Volume 23, Number 20 October 31, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 40866, 40880, and 41314.

40532 (IDO-12071, pp 18-24) ANALYTICAL CHEMISTRY BRANCH. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

Progress is reported under the following headings: routine analytical chemistry activities, evaluation of ^{222}Rn near uranium tailings piles, whole-body counting research, in vivo determination of ^{90}Sr, alpha and gamma spectroscopy, determination of ^{35}S in vegetation, development of a clean filter for activation purposes, determination of in vivo ^{235}U, determination of ^{129}I by activation analysis, determination of ^{55}Fe, determination of ^{90}Sr, IAEA intercomparison of analytical methods and standard samples, fluorometric determination of Zr, and determination of U and transuranium elements. (M.C.G.)

40533 (ORNL-tr-2186) ANALYTICAL CHEMISTRY OF THE TRANSURANIUM ELEMENTS. Baeckmann, A. V. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Atompraxis, 15: 15-17(1969). 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 19620.

Chemical Procedures

Refer also to abstracts 40797 and 41770.

40534 (BNL-50149, pp 26-39) CHEMISTRY DIVISION. Wiswall, R. H. Jr. (Brookhaven National Lab., Upton, N. Y.).

Neutron scattering data recorded for molten KCl, $ZnCl_2$, and their binary mixtures indicate the existence of definite dispersion relations for the phonon modes in these melts. Studies on double layer capacitance in molten salts were continued. Capacitance in molten salts were continued. Capacitance curves were obtained by the use of molten lead and bismuth dropping electrodes in LiCl-KCl eutectic. Studies on the solution chemistry of halogen gases dissolved in their respective halides were continued. Cathodic chromopotentiograms were obtained for chlorine dissolved in molten AgCl, $PbCl_2$, and LiCl-KCl eutectic. The solubility of bromine in molten LiBr and $PbBr_2$ was measured as a function of temperature. The rate of radiolytic decomposition as a function of temperature of decafluorobiphenyl, hexafluorobenzene, octafluoronaphthalene, and tetradecafluoro-o-terphenyl was studied. Investigation of the combined effects of radiolysis and pyrolysis on perfluorobicyclohexyl were continued. Cation radicals of various porphyrins were prepared by chemical and electrochemical oxidations. The reaction of graphite and hydrogen was studied at temperatures above 3000°K to determine the mechanism of formation and the reaction products. The rate of vaporization of graphite in vacuum was measured at 2400 to 3400°K. Composition of the vapor was studied spectroscopically. The reactions of hydrogen with a large number of alloys were investigated. Thermodynamic data are presented on hydrogen uptake by Fe-Ti, V, Ti-V, and V-Zr. The rate of evolution of H_2 from Mg_2NiH_4 was measured. (J.G.B.)

40535 (CEA-N-1044, pp 3-50) CHEMICAL ANALYSIS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

The development of various analytical methods is reported. This includes the chemical analysis of plutonium, chemical and electrochemical analysis in solution, optical emission methods, atomic absorption methods, x-ray fluorescence methods, and control of nuclear materials. A method is also described for the preparation of irradiated or reconstituted fuel solutions (U and Pu) for analysis. (P.C.H.)

40536 (EURFNR-631) POLAROGRAPHIC STUDIES ON THE AUTOMATIC ASSAY OF URANIUM IN NUCLEAR FUEL SOLUTIONS. Thiele, D.; Baumgaertel, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK-869. 21p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 31280.

40537 (MHSMB-3) A RAPID GAS-LIQUID CHROMATOGRAPHY METHOD FOR THE QUANTITATIVE ANALYSIS OF 1, 1, 2 TRICHLORO 1, 2, 2 TRIFLUORO ETHANE (FREON 113) IN AIR. Technical Report No. 163. Stull, T. W. (Mason and Hanger-Silas Mason Co., Inc., Burlington, Iowa). Oct. 10, 1968. Contract W-49-010-AMC-68(A). 13p. (AD-679035). Dep. CFSTI.

A rapid method is described for the quantitative determination of 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113) in atmospheric concentrations ranging from 1 to 1000 ppM. This gas-liquid chromatographic method utilizes the flame ionization detector and employs a unique method of standardization. The standard can be prepared and a complete concentration range chromatographed and graphed in approximately fifteen minutes. Both lower and higher concentrations can be determined by adjustment of the prepared standard, instrument conditions, or sample size injected. The method outlined was used for approximately two years and proved both reliable and accurate. Its advantage lies in the ease, simplicity, and rapidity of both standardization and subsequent analysis. (auth)

40538 (PB-183567) A CONTINUOUS ELECTROCHEMICAL METER FOR MEASUREMENT OF HYDROGEN IN SODIUM. Progress Report, October 1-December 31, 1968. Fuhrman, M.; Liggett, L.; Lukasik, S.; Holden, R. B.; Lubitch, G. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Mar. 18, 1969. Contract AT(30-1)-3908. 43p. (UNC-5239). CFSTI.

Fifteen experimental electrochemical hydrogen sensors were tested in hydrogen-argon mixtures at several hydrogen levels ranging down to concentrations equivalent to 0.5 ppM hydrogen in sodium. Several new electrolytes were screened and it was shown that electrolytes consisting of molten salts with oxide additions form the basis of a class of hydrogen sensors just as in the case of ionic hydride-bearing molten salts tested previously. Three sensors representing three classes of electrolytes: oxide-activated, solid state (hydride-activated), and all-lithium cation (hydride-activated) were sufficiently sensitive to meet the target sensitivity requirements for the device. A sensor containing 1.2 mole % CaO in LiCl-KCl eutectic was found to be the most reproducible. (auth)

40539 (TRG-Report-1850) THE GAS CHROMATOGRAPHIC ANALYSIS OF CARBON DIOXIDE BASED GAS MIXTURES USING MOLECULAR SIEVE 13X AND TEMPERATURE PROGRAMMING. Robinson, H. L.; Walker, J. A. J. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Mar. 13, 1969. 4p. Dep. CFSTI (U. S. Sales Only). UK 1s. 2d.

An analytical technique for determination of permanent gases (i.e., H_2, O_2, N_2, CH_4, and CO in carbon dioxide is described. At a chromatographic column temperature of 100°C, the retention volume of CO_2 on a molecular sieve is large compared with the retention volumes of the permanent gases. However, for a high sampling frequency, or for automation of the analysis, the CO_2 may be removed rapidly from the column, after elution of the permanent gases, by raising the column temperature to 300°C for 20 min followed by forced cooling to the original operating temperature. (auth) (UK)

40540 STUDY OF THE COMPLEXES OF THORIUM WITH MORIN. Babko, A. K.; Chang Tu Hieu; Volkova, A. I.; Getman, T. E. Ukr. Khim. Zh., 35: 642-8(1969). (In Russian).

A detailed study was made of the spectrophotometric and luminescent properties of morin and its complexes with thorium. An investigation of the effects of various organic solvents on the luminescence showed that the best solvent for determination of thorium by the luminescent method using morin is methanol. (M.C.G.)

40541 ANALYTICAL UTILITY OF THE UNIQUE COLOUR REACTION BETWEEN URANYL IONS AND ALIZARIN FLUORINE BLUE. Leonard, M. A.; Nagi, F. I. (Queen's Univ., Belfast). Anal. Lett., 2: 15-23(Jan. 1969).

The uranyl-alizarin fluorine blue chelate complex shows an absorption peak at 560 nm, 30 nm higher than that of any other single metal complex of the reagent. The complex shows, at pH 4.5, a conditional stability constant of 2.3×10^6 liters $mole^{-1}$ and molar absorptivity of 4100 liters $mole^{-1}$ cm^{-1}. Study of the feasibility of using this reaction for the photometric determination of UO_2^{2+} in both one and two liquid phase systems reveals serious interference from other metal ions. (auth)

40542 EFFECT OF VARIOUS CATIONS AND ANIONS ON THE REDUCTION OF MOLYBDENUM(VI) AT D.M.E. AND ITS DETERMINATION IN THEIR PRESENCE. Mittal, M. L. (Malaviya Regional Engineering Coll., Jaipur, India). Z. Naturforsch., 24b: 1053-5(Aug. 1969).

The effects of the presence of Ni^{2+}, Co^{2+}, WO_4^{2-}, VO_3^-, $Cr_2O_7^{2-}$, Mn^{2+}, TeO_4^{2-}, Fe^{3+}, Ti^{2+}, ClO_4^-, UO_2^{2+}, and NO_3^- on the polarographic wave produced by Mo^{6+} were determined. Observations indicated that the Mo^{6+} can be determined successfully in the presence of the various cations and anions at concentrations above 25 mg/l. (M.C.G.)

40543 SPECTROPHOTOMETRIC DETERMINATION OF LANTHANUM(III) WITH CHROMAZUROL S. Ishida, Ryoei (Hokkaido Univ. of Education, Japan). Bunseki Kagaku, 18: 827-32(July 1969). (In Japanese).

Chrome Azurol S reacts with lanthanum(III) ion to form two kinds of colored complexes depending on pH value of the medium. It was estimated that one in a slightly acidic medium had a 1:2 molar ratio of lanthanum(III) and Chrome Azurol S with its absorption maximum at 500 mμ, and the other in a nearly neutral medium had a 1:1 molar ratio with its absorption maximum at 610 mμ. These complexes were slightly insoluble in water, but they were soluble in aqueous acetone. The 1:2 complex giving the maximum 500 mμ absorbance in the pH range from 6.0 to 6.6 was more sensitive and was applied to the determination of lanthanum(III). The color development was almost instantaneous, and the absorbance remained constant for several hours. About a 7.5-fold excess of Chrome Azurol S over the lanthanum(III) concentration was necessary to obtain the maximum color intensity. The appropriate concentration of acetone was about 5%. The color obeyed Beer's Law over the concentration range up to 100 μg of lanthanum(III) in 10 ml. The apparent molar absorbancy at 500 mμ was 15,000 corresponding to a sensitivity index of 0.009_2 $\mu g/cm^2$ for an absorbance of 0.001. Cyanide, phosphate, and polycarboxylate such as citrate and EDTA bleached the color of the complex, even when a small amount was present. Many cations also interfered with the determination of lanthanum(III). (auth)

40544 DETERMINATION OF MOLYBDENUM IN STEEL BY ATOMIC ABSORPTION SPECTROMETRY. Endo, Yoshihide; Hata, Toshihiko; Nakahara, Yuki (Kawasaki Steel Corp., Okayama, Japan). Bunseki Kagaku, 18: 878-82(July 1969). (In Japanese).

In the atomic absorption spectrometric determination of molybdenum in N_2O—acetylene flame, an addition of potassium sulfate increased the sensitivity and suppressed the influence of diverse elements. This fact was applied to the determination of molybdenum in steel. In the recommended procedure, 0.5 g of sample was dissolved in acid, 0.5 g of potassium sulfate added, and the solution was made up exactly to 100 ml. It was sprayed into N_2O—acetylene flame and the absorption at 3133 Å was measured. The concentration of Mo giving 1% absorption by this procedure was 0.3 ppM and the limit of detection (S/N = 2) was 0.05 ppM. (auth)

40545 CATALYTIC METHOD FOR THE DETERMINATION OF RUTHENIUM. Ottaway, J. M.; Fuller, C. W.; Allan, J. J. (Univ. of Strathclyde, Glasgow). Analyst, 94: 522-6(July 1969).

A method is outlined for the determination of ruthenium based on its catalysis of the periodate oxidation of the tris(1,10-phenanthroline)iron(II) complex. This reaction was used to detect 10^{-10} $\underline{M}$ ruthenium and to determine 10^{-9} to 2×10^{-8} $\underline{M}$ ruthenium, with a coefficient of variation of 4.8%. The interference effects of various ions were studied and the method was shown to have only three serious interferences; iridium, osmium, and rhenium. The sensitivity attained compares favorably with other methods by which ruthenium can be determined. (auth) (UK)

40546 COLUMN CHROMATOGRAPHIC SEPARATION OF PLUTONIUM OXIDATION STATES IN THE SYSTEM AG50X8—HCl. Specht, S.; Hoehlein, G. (Technische Hochschule, Munich). Radiochim. Acta, 12: 38-42(July 1969). (In German).

An analytical method of column chromatography is described which permits the identification of trace amounts of plutonium (III, IV, and VI). The cation exchange resin AG50X8 (300 and 400 mesh) and HCl is used as the eluant. Identification is based on the position of the elution bands obtained. The distribution coefficients K_d, the separation factors α, the plate numbers N, and the HETP-values are shown as a function of HCl concentration and the optimum conditions of separation are discussed by examples. The K_d-values were compared with those for americium, sodium, and the rare earth metals praseodymium and europium. (auth)

40547 TWO-PHASE EXTRACTION TECHNIQUE FOR DETERMINATION OF SOLUBLE TRACE ELEMENTS IN SOIL. Lakanen, E. (Agricultural Research Centre, Tikkurila, Finland). Ann. Agr. Fenn., 6: 106-13(1967).

Traces of Ag, Bi, Cd, Co, Cu, Fe, Ga, Mn, Mo, Ni, Pb, Sn, Tl, V, and Zn in soils were determined spectrographically after extraction into a $CHCl_3$ phase as the chelates of tetramethylenedithiocarbamic acid. The soil sample was shaken for 1 hr with a 1:1 mixture of 0.5$\underline{M}$ acetic acid and 0.5$\underline{M}$ ammonium acetate buffer (pH 4.65) and with 0.15 $\underline{M}$ tetramethylenedithiocarbamic acid. (B.L.M.)

40548 SPECTROPHOTOMETRIC DETERMINATION OF RARE-EARTHS BY EXTRACTION OF THE COMPLEXES WITH 8-HYDROXYQUINOLINE AND CALCIUM. Keil, R. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Z. Anal. Chem., 245: 362-6(May 21, 1969). (In German).

A simple and reliable method is described for the determination of the rare earth elements based on the photometric evaluation of the double complex compound of calcium and the rare earth elements with 8-hydroxyquinoline extracted into chloroform. Errors amount to ±2% maximum. (auth)

40549 SPECTROPHOTOMETRIC DETERMINATION OF RHENIUM IN THE PRESENCE OF MOLYBDENUM AND TUNGSTEN. Klofutar, C.; Podobnik, B.; Krasovec, F.; Stular, V. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Mikrochim. Acta, No. 4, 758-63(1969).

Rhenium(VII) can be separated on a column of Al_2O_3 from a 500-fold excess of Mo(VI) and W(VI) and a 250-fold excess of Cr(III), Mn(II), Ni(II), Co(II), and Fe(III) by elution with 0.1 $\underline{M}$ NaCl. For photometric determination, rhenium(VII) is reduced with Sn(II), extracted as the thiocyanate complex into isopropyl ether, and measured at 430 nm. The sensitivity is 0.04 μg/ml, if 10-mm cells are used. The interferences were examined statistically and found to be negligible. (auth)

40550 NEW SPOT TEST FOR CERIUM(IV). Krishna, U. Murali; Sreeramam, K. (Andhra Univ., Waltair, India). Mikrochim. Acta, No. 4, 768-71(1969).

A new color reaction for the detection of cerium(IV) which can be carried out both in a test tube and on a spot plate is described. The test solution is treated with methylene blue in nitric acid solution (1:1) to form a rose-red color. This simple procedure has an advantage over the existing tests in that it is applicable in the presence of oxidizing agents, such as chromium(VI), vanadium(V), nitrate, perchlorate and of colored ions, such as copper(II), cobalt(II), nickel(II), chromium(III), iron(III), vanadium(IV), and uranium(VI). (auth)

40551 ACID ALIZARIN BLACK SN AS REAGENT FOR EXTRACTION PHOTOMETRIC DETERMINATIONS OF METALS. Gagliardi, E.; Khadem-Awal, M. (Univ., Graz). Mikrochim. Acta, No. 4, 882-7(1969). (In German).

Acid alizarin Black SN is a sensitive reagent for the spectrophotometric determination of Cu, U, Bi, Th, Fe, Mo and V. Procedures are given for the individual metals and also for masking agents to avert interferences. All metal chelates can be extracted from aqueous solution and then determined photometrically. The addition of a C_1 to C_3-alcohol to the metal dyestuff chelate in aqueous solution results in an increase of the extinction to varying degrees. (auth)

40552 DETERMINATION OF TANTALUM WITH NILE BLUE A. Gagliardi, E.; Wolf, E. (Univ., Graz). Mikrochim. Acta, No. 4, 888-93(1969). (In German).

A spectrophotometric determination of tantalum by means of the dyestuff Nile blue A in the presence of hydrofluoric and sulfuric acid is described. The extraction of the TaF_6–Nile blue associate is accomplished with chlorobenzene. Other metals do not interfere. A procedure is given for the determination of tantalum in steel or niobium metal. (auth)

40553 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM BY THE 1-PYRROLIDINECARBODITHIOATE METHOD. Traub, Amos; Boltz, D. F. (Wayne State Univ., Detroit). Mikrochim. Acta, No. 4, 749-52(1969).

A spectrophotometric method for the determination of uranyl ion is proposed which is based on the use of ammonium 1-pyrrolidinecarbodithioate as the chromogenic reagent. Conformity to Beer's law was observed for the range between 0 to 50 ppM of uranium when spectrophotometric measurements are made at 385 nm. (auth)

40554 LUMINESCENCE OF THE PHOSPHOR SiO_2–Na_2SO_4–Gd AND ITS UTILIZATION FOR DETERMINATION OF MICRO-QUANTITIES OF GADOLINIUM. Anikina, L. I.; Dobrolyubskaya, T. S.; Karyakin, A. V.; Lieh Vet Pin. Zh. Prikl. Spektrosk., 10: 518-20(Mar. 1969). (In Russian).

The luminescence of the phosphor SiO_2–Na_2SO_4–Gd was studied. Optimum conditions for preparation of the phosphor are calcination at 1050°C for 30 min and a Na_2SO_4 concentration of 10%. Only terbium of the other rare earths luminesces in this SiO_2–Na_2SO_4 base and it has a green luminescence. The quenching effects of Cr(III), Fe(II), Fe(III), Mn(II), Ni(II), Cu(II), Ce(III), and Ce(IV) began to be noticeably manifested at concentrations of 10^{-3}%. A linear relation between intensity of luminescence and concentration of gadolinium was observed in the whole range studied. Use of the luminescence of Gd in this phosphor for determination of microquantities of this element in rare earth compounds, uranium, etc., is proposed. (tr-auth)

40555 DETERMINATION OF NIOBIUM AND TANTALUM BY ROENTGENORADIOMETRIC METHOD. Ostroumov, G.V.; Tokareva, D. V.; Arkhipov, A. A.; Kudryashov, E. S. Zavod. Lab., 35: 669-72(1969). (In Russian).

The roentgenoradiometric method and apparatus for determination of tantalum and niobium in certain minerals are described. Hypothetical standards are used to remove the effect of composition of samples and the procedures developed to calculate the effects of interfering elements. Limitations of the method in the presence of Y, W, Hf, Er, and Tm are shown. (tr-auth)

40556 X-RAY-SPECTRAL DETERMINATION OF YTTRIUM IN PRODUCTS FROM HYDROMETALLURGICAL PRODUCTION. Antonov, A. V.; Renev, V. K.; Spitsyn, P. K.; Troneva, N. V. Zavod. Lab., 35: 672-6(1969). (In Russian).

The x-ray-spectral determination of yttrium in production solutions (0.05 to 100 g/l Y_2O_3) and powders (0.02 to 80% Y_2O_3) was studied from the point of view of requirements of technology. Internal and external standards and the method of additions were evaluated. In the region of 10 to 30% Y_2O_3 in powders and 1 to 10 g/l Y_2O_3 in solutions, the total coefficient of variation for each method was about 5%. (tr-auth)

40557 DETERMINATION OF THE CONTENT OF TANTALUM FROM THE K-EDGE ABSORPTION FOR SAMPLES OF CONSTANT LAYER THICKNESS. Abdulin, S. F. Zavod. Lab., 35: 676-8 (1969). (In Russian).

The possibility of absorption analysis for determination of tantalum based on the K-edge absorption for samples of constant layer thickness was investigated. (tr-auth)

40558 APPLICATION OF AUTOMATIC CHEMICAL ANALYSIS IN THE URANIUM ORE INDUSTRY. Desson, M. Rev. Ind. Minerale, 50: No. 3, 190-8(Mar. 1968). (In French).

Problems connected with the use of ion exchange methods in the treatment of uranium minerals are reviewed. In conjunction with these techniques, use of an automatic device, Technicon, for the determination of uranium has been found to be advantageous. It is particularly adapted to determinations involving colorimetric measurements. (J.G.B.)

40559 RUBIDIUM AND STRONTIUM DETERMINATIONS BY X-RAY FLUORESCENCE SPECTROMETRY AND ISOTOPE DILUTION BELOW THE PART PER MILLION LEVEL. Chappell, B. W.; Compston, W.; Arriens, P. A.; Vernon, M. J. (Australian National Univ., Canberra). Geochim. Cosmochim. Acta, 33: 1002-6(Aug. 1969).

The rubidium and strontium contents of dunite DTS-1 and peridotite PCC-1, and of rubidium in a standard pyroxene Px-1, were measured by x-ray fluorescence spectrometry and by isotope dilution. Both techniques are useful in determining low concentrations of these elements. (auth) (UK)

40560 POLAROGRAPHIC DETERMINATION OF PLUTONIUM(V) IN NON-COMPLEXING MEDIUM. Guichard, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Chem. Anal. (Warsaw), 14: 473-9(1969). (In French).

The examination of apparent normal potentials of various redox systems showed that in noncomplexing medium, Pu(V) is stabilized starting from pH = 1.2. On the other hand Pu(VI) can be reduced to Pu(V) on a dropping mercury electrode. Hence plutonium(V) can be determined polarographically in perchloric acid medium after oxidation of plutonium to Pu(VI). The plutonium in concentrations of the order of 10^{-4} $\underline{M}$ can be determined by this method. The sensitivity is thus nearly comparable with that obtained with α-counting and better than the sensitivity of volumetric methods. (auth)

40561 ISOTOPIC ANALYSIS OF URANIUM BY AN OPTICAL SPECTRAL METHOD. III. DETERMINATION OF $^{235}U/^{238}U$ RATIOS WITH A HOLLOW-CATHODE SOURCE AND A DIRECT-READING ATTACHMENT. Rossi, G.; Mol, M. (CCR-EURATOM, Ispra, Italy). Spectrochim. Acta, Part B, 24: 389-98(Aug. 1969).

A direct-reading optical spectral method for uranium isotope analysis is described. A slow scanning exit slit-photomultiplier assembly was designed and mounted on the Jarrell–Ash 3.4 m Mark IV spectrometer, the line intensities being recorded through a phase sensitive a.c. amplifier system. The pelleting of U_3O_8 with Cu powder results in a fast and reliable preparation method for the deposition of the sample into the cathodes of the hollow cathode lamp, allowing stable and intense light output to be reached within a few minutes after the discharge has been struck. Uranium-235 concentrations from 0.5 to 93% can be determined with a precision, at 99% confidence level, ranging from 1.97 to 0.28%. (auth)

40562 VOLUMETRIC DETERMINATION OF LANTHANUM USING SODIUM TUNGSTATE IN PRESENCE OF ADSORPTION INDICATORS. Wawrzyczek, Wiktor; Bukowska, Alina. (Landwirtschaftliche Hochschule, Olsztyn, Poland). Z. Anal. Chem., 246: 9-11(June 9, 1969). (In German).

The accurate and rapid method described employs the following indicators: chlorophenol red, o-cresol red, methyl red, and the mixtures methyl red + bromocresol green and chlorophenol red + aniline blue. In all instances the error is smaller than 0.5%. The method is suitable for La^{3+} determination in lanthanum salts and also for the determination of the total amount of rare earths after separation from other heavy metals by forming with sodium tungstate difficultly soluble precipitates. (auth)

40563 FLAME-PHOTOMETRIC DETERMINATION OF LANTHANUM IN THE PRESENCE OF PHOSPHATE. Slevin, P. J.; Svehla, G. (Queen's Univ., Belfast). Z. Anal. Chem., 246: 5-9 (June 9, 1969).

Optimum experimental conditions for the emission flame-spectrophotometric determination of lanthanum were examined. A wavelength of 440 nm at a slit width of 0.1 mm was chosen as most satisfactory. Lanthanum was determined in the presence of phosphate by a substitution method using cerium. The error of lanthanum determinations in the presence of phosphate might exceed −50 to −70% if a simple calibration technique is applied but using a substitution method combined with standard addition these errors can be reduced to within 6%. (auth)

40564 NATURAL FRACTIONATION OF LITHIUM ISOTOPES. Isakov, Yu. A.; Plyusnin, G. S.; Brandt, S. B. Geokhimiya, No. 6, 748-51(June 1969). (In Russian).

Variations of the isotopic composition of lithium in rare metal granites with the various degrees of albitization and greisenation were studied. Determinations of $^7Li/^6Li$ were made mass spectrometrically with various ion sources. (tr-auth)

40565 THE SPECTROPHOTOMETRIC DETERMINATION OF SCANDIUM WITH CHROMAL BLUE G. Uesugi, Katsuya (Himeji Inst. of Tech., Japan). Bull. Chem. Soc. Jap., 42: 2051-4(July 1969).

A new method for the spectrophotometric determination of Sc using Chromal Blue B (sodium-2″-chloro-4″-nitro-4′-hydroxy-

3,3′-dimethylfuchsone-5,5′-dicarboxylate, Colour Index 43835), similar in structure to Pontachrome Azure Blue B, Eriochrome Cyanine R, and Chromazurol S, is described. The method is based on the highly sensitive colored reaction of Chromal Blue G with Sc in an acetate buffer solution. (P.C.H.)

40566 COPPER(II) AS AN AMPEROMETRIC INDICATOR: DETERMINATION OF THORIUM. Dean, J. R.; Harris, W. E. (Univ. of Alberta, Edmonton). Anal. Lett., 2: 93-7(Feb. 1969).

Copper(II) is applicable as an amperometric indicator for the titration of small amounts of Th in solution using EDTA as the titrant. Best results are obtained when the mole ratio of Th to Cu is high. Prior to the equivalence point the important reaction is the complexation of Th with EDTA. At or near the equivalence point the competition of Cu and Th for EDTA must be considered, but the K_{eq} lies in favor of Th by a factor of 2.5×10^3. To the sample containing 5 to 10 mg Th, 5 ml of 0.15M $ClCH_2COOH$ and 4 ml 5×10^{-4}M Cu(II) are added. The solution is diluted to 70 ml, and the pH is adjusted to 3.1 ± 0.1 by the addition of 0.2M NaOH. After deaeration with N_2 for 5 min, a potential of 0 V vs saturated calomel electrode is applied to a clean rotating Pt electrode. Titration is carried out with standard 2×10^{-2}M EDTA. The current is measured with an instrument having a sensitivity of about 0.1 μa/cm. Correction must be made for the dilution effect prior to determination of the end point by extrapolation of the 2 straight lines obtained by plotting diffusion current against volume. (BBB)

Isotopic Procedures

Refer also to abstract 41769.

40567 A THEORETICAL STUDY OF THE USE OF INTERNAL STANDARDS FOR PRECISE ISOTOPIC ANALYSIS BY THE SURFACE IONIZATION TECHNIQUE. PART II. ERROR RELATIONSHIPS. Dodson, M. H. (Univ. of Leeds, Eng.). J. Phys., E (London), 2: 490-8(June 1969).

Using an idealized model it is shown that, to minimize errors in double-spiked isotopic analyses, spike mass numbers should alternate with normal. The comprehensive error analysis given assumes that the individual ion currents are the independent variates for statistical purposes; errors in these are obtained by combining (i) a coefficient of variation e_p due to fluctuations in ion emission with (ii) a resistor noise index e_R and (iii) a shot noise index e_s. The noise indices are the ratios [error due to noise noise]/[error (i) due to emission fluctuation] for the largest ion beam in the spectrum. Methods of computing error multipliers (operating on e_p) from e_R, e_s and the isotopic abundances, are developed. For a particular element each error multiplier can be regarded as a function of two variables, the ratio of the two spikes selected and the spike/normal ratio, which can then be optimized by numerical methods. Optimum values of spike composition and spike/normal ratio are given for observations of isotopic fractionation of lead, molybdenum and iron using various pairs of spike mass numbers. If both noise indices are taken to be zero the minimum error multipliers are not very much increased by deviations from the ideal model. When e_R is given values corresponding to experience with a typical electrometer, it is shown that satisfactory results would be obtained on Pb and Mo with quite low ion currents, but that for iron, because of its difficult isotopic composition, the maximum ion current should be as large as possible. Some possible deviations from first-order fractionation theory are considered. A general algebraic analysis for the determination of radiogenic isotopes is given, and different approaches to fractionation computations are discussed. (auth) (UK)

40568 NMR SPECTROSCOPIC DETERMINATION OF WATER IN DEUTERIUM OXIDE/WATER MIXTURES. Johnson, Wendell; Keller, Roy A. (Univ. of Arizona, Tucson). Anal. Lett., 2: 99-104(Feb. 1969).

Synthetic mixtures of 70 to 100% D_2O and 90 to 100% D_2O were analyzed for D_2O by NMR spectroscopy with a Varian A-60 NMR spectrometer using peak heights and areas. A study of instrument settings that would improve sensitivity and precision was made. In the range 90 to 100% D_2O, the optimum conditions appeared to be (1) SwW = 100 cps, SwO = 200, SpA = 1.0, dp = 12; PcD = 99.61−0.009305 A; s(A) = 40, s(D) = 0.4% D_2O, $r^2 = 0.9905$; or (2) SwW = 100 cps, SwO = 200, SpA = 1.0, dp = 6; PcD = 99.86−0.009855 A; S(A) = 43, s(D) = 0.4% D_2O, $r^2 = 0.9872$; where SwW is sweep width, SwO is sweep offset, SpA is spectrum amplitude, PcD is percent D_2O (v/v), A is peak area, mm^2, S(A) is standard deviation of area, s(d) is standard deviation of percent D_2O, dp is the number of data points, and r^2 is the linear regression coefficient. Thus exploitation of the instrument capabilities provides superior results without introduction of additional chemical steps. (BBB)

40569 STUDIES ON THE ANALYSIS OF DRUGS BY RADIOISOTOPES. 5. IDENTIFICATION OF METABOLITES OF EPHEDRINE IN THE RABBIT LIVER. Baba, Shigeo; Matsuda, Akitada (Tokyo Coll. of Pharmacy). Yakugaku Zasshi, 89: 833-6(June 1969). (In Japanese).

l-Ephedrine (α-^{14}C, ca. 1×10^6 dpm/mg) was incubated with a rabbit liver preparation (supernatant fraction of 15,000 g, 20 min centrifugation and $NADPH_2$ regenerating system) for 2 hr. The metabolites were separated by paper partition and thin-layer chromatography and were determined by the reverse isotope dilution analysis. Norephedrine (33.4%), 1-phenyl-1,2-propanediol (11.4%), 1-hydroxy-1-phenyl-2-pentanone (4.2%), and benzoic acid (39.3%) were identified as the metabolites together with unchanged ephedrine (6.2%). (NSA of Japan)

40570 LIMITATIONS IN ISOTOPIC MEASUREMENTS OF LABILE PHOSPHATE IN SOILS. Amer, F. (Univ. of Alexandria, Egypt); Mahdi, S.; Alradi, A. J. Soil Sci., 20: 91-100(Mar. 1969).

Radioisotopic measurements can be used for estimation of labile P, i.e., the sum of solution P and solid-phase P (surface P) that exists in equilibrium with soil solution. Laboratory measurements give isotopically or ^{32}P exchangeable phosphorus, or E values, whereas measurements obtained in plant experiments are frequently termed A or L values. Methods used for measuring these values and assessing the phosphate-fertility status of soils by radioisotopic dilution as well as assumptions involved in applying the isotope dilution technique were critically evaluated. In the presence of high phosphate-fixing compounds, e.g., reactive iron oxide, labile P may be erroneously overestimated, especially when carrier-free ^{32}P is used. At the end of the isotopic-exchange reaction period, high phosphate-fixing soils may have a higher specific activity in the solid phase than in the solution phase. Methods involving the use of a 0.2 ppM P carrier solution or the addition of an unlabeled carrier to a labeled soil may give satisfactory labile P measurements in low and in medium phosphate-fixing soil. All the methods tried (carrier-free, carrier, and inverse dilution), however, failed to give satisfactory results for the high phosphate-fixing soils. (BBB)

Radiometric Procedures

Refer also to abstracts 40610, 40797, 41018, 41021, 41042, and 41130.

40571 (ORNL-IIC-18) RADIO-RELEASE IN REVIEW WITH SPECIAL EMPHASIS ON ^{85}Kr CLATHRATES AND KRYPTONATES. Carden, Joan E. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 46p. Dep. CFSTI.

A review is presented that discusses the development of the radio-release method, in which a nonradioactive component is determined indirectly by the quantitative release of a radioactive material from a radioactive reagent with which the sample is contacted. Eighteen successful radio-release techniques are discussed in detail with special emphasis on the highly versatile kryptonates, and sensitivity data are presented. Discussions of the nonkrypton analytical tracer techniques, such as the determination of active hydrogen with lithium aluminum tritide, and of the ^{85}Kr clathrates precede the discussion of the preparation, properties, and numerous applications of the kryptonates. (auth)

40572 DETERMINATION OF SILICON IN SOLUBLE SODIUM SILICATES BY THE METHOD OF NONDISPERSIVE X-RAY FLUORESCENCE EXCITED BY USE OF A RADIOACTIVE SOURCE. Wasilewska, M.; Robert, A. (CEA, Saclay, France). Radiochem. Radioanal. Lett., 1: 263-72(Aug. 13, 1969). (In French).

A method is described in which nondispersive x-ray fluorescence excited by the radioisotope ^{55}Fe is used for the determination of the Si content, in industrial silicates. A nondispersive spectrometer with a detector with a gaseous window and a sample-changer is described. The operating conditions such as: the primary radiation energy, the detector gas and its pressure, as well as sample preparation techniques have been studied. For concentrations of SiO_2 between 56.1 and 69.1% by weight the relative precision, one standard deviation, of 0.87% has been obtained. The average time for such an analysis, including the preparation of the sample, is about 5 minutes. The sensitivity of the determination of Si content obtained with this apparatus was compared with that of a classical-type spectrometer with an x-ray tube. (auth)

40573 γ-SPECTROMETRY OF ^{147}Nd IN FISSION PRODUCT LANTHANIDES. Sutton, D. W.; Vallis, D. G. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Radiochem. Radioanal. Lett., 1: 319-24(Aug. 25, 1969).

^{147}Nd is determined in mixed fission product lanthanides by γ spectrometry using the 0.091-MeV photopeak. Interference from other lanthanides in fission products produced by neutrons of up to fission spectrum energies is negligible twelve days after irradiation. (auth)

40574 TENTATIVE METHOD OF ANALYSIS FOR ^{222}Rn CONTENT OF THE ATMOSPHERE. Shleien, B.; Hanson, O. G.; Heatherton, R. G.; Hildebrandt, P. F.; Lockhart, L. B.; Morse, R. S.; VanFarowe, D. E. Health Lab. Sci., 6: 114-29(Apr. 1969).

Methods are given for estimation of airborne ^{222}Rn by filter paper collection and α or β activity measurement of its daughters, and for determination of airborne ^{222}Rn by its adsorption from the atmosphere and α or γ activity measurement. The first method is based on collection and measurement of the short-lived Rn daughters whose activity is then related to the parent gaseous Rn concentration. The α activity of RaC′ (^{214}Po), and to a lesser extent that of RaA (^{218}Po) is measured and, assuming equilibrium conditions between Rn and its short-lived daughters, the concentration of the parent radionuclide, ^{222}Rn, can be calculated. The average α half-life of the combined Rn daughters is ~36 ± 5 min so that after 4 hr of sampling the collection rate of the short-lived Rn daughters on the filter is essentially equivalent to their decay rate on the filter. The lower detection limit for this method is 30 pCi/m^3 for α counting and 15 pCi/m^3 for β counting. In another method, gaseous Rn is collected by adsorption from the atmosphere by passage over activated charcoal at −78°C. It is used in studies of low levels of Rn or where high sensitivity is required (3 pCi/sample). The last method involves entrapment of air containing Rn. Radon and daughters are not isolated from air, but are counted directly. The sensitivities with this method for α, β, and ionization chamber counting are 2.5×10^4 pCi/m^3, 120 pCi, and 1.0×10^4 pCi/m^3, respectively. (BBB)

40575 TENTATIVE METHOD OF ANALYSIS FOR ^{210}Pb CONTENT OF THE ATMOSPHERE. Shleien, B.; Hanson, O. G.; Heatherton, R. G.; Hildebrandt, P. F.; Lockhart, L. B.; Morse, R. S.; VanFarowe, D. E. Health Lab. Sci., 6: 102-5(Apr. 1969).

Lead-210 (21-yr half-life) is a trace component of the normal atmosphere and is produced through decay of ^{222}Rn, which diffuses into the air from Ra sources in the soil; it is removed by washout, precipitation, and dry deposition processes (fallout). Though normal Rn concentrations over land are generally in the range of 10 to 1000 pCi/m^3, the concentration of airborne ^{210}Pb rarely exceeds 25 pCi/1000 m^3. Consequently, large volumes of air must be sampled to obtain a statistically significant count rate of ^{210}Pb. Analysis is performed by dissolution of a filter through which a known volume of air has passed, addition of inactive Bi as a carrier for the 5.0-day ^{210}Bi daughter of ^{210}Pb, separation and radiochemical purification of the ^{210}Bi, and determination of its count rate relative to a ^{210}Bi standard. The filter sample should be retained sufficiently long before analysis to assure near secular equilibrium between ^{210}Pb and ^{210}Bi (e.g., 30 days). With this procedure ^{210}Pb concentrations as low as 1 pCi/1000 m^3 can be determined with a standard error of less than ±10%. (BBB)

40576 EXTRACTIVE RADIOMETRIC TITRATION AS A METHOD OF CHECKING THE EXTRACTION OF GOLD WITH DIETHYLDITHIOCARBAMATES. Kukula, F.; Krivanek, M.; Kyrs, M. (Nuclear Research Inst., Rez, Czech.). J. Radioanal. Chem., 3: 43-52(July 1969).

The extraction of gold(III) by copper, zinc, and mercury diethyldithiocarbamates from acid medium was studied by means of extractive radiometric titration, using trichloromethane or benzene as the solvent. Two end-points corresponding to the molar ratios 1 Au : 1 DDC and 1 Au : 2 DDC were observed on the titration curve of trivalent gold when diethyldithiocarbamate ion (DDC) was used as the titrant. Two compounds are formed successively: $Cl_2Au^{III}DDC$ and $\{[Au^{III}(DDC)_2]^+ \cdot Cl^-\}$. The first compound is completely extracted into trichloromethane or benzene; the extractibility of the second compound increases with increasing solvent polarity. Univalent gold forms only one compound with the diethyldithiocarbamate ion: AuDDC. (auth)

40577 DIRECT DETERMINATION OF URANIUM IN ORGANIC EXTRACTS. I. EXTRACTION OF URANIUM WITH BIS(2-ETHYLHEXYL) ESTER OF PHOSPHORIC ACID. Sorantin, H. (Institut fuer Chemie, Seibersdorf, Austria. Studiengesellschaft fuer Atomenergie, GmbH, Vienna). J. Radioanal. Chem., 3: 65-79(July 1969). (In German).

Uranium was extracted with a 0.15M bis(2-ethylhexyl) phosphate solution in toluene, and directly determined in the organic phase by the liquid scintillation technique. The selection of the optimum conditions of measurement are discussed with the use of an established isoamplitude curve. ^{235}U was determined in the presence of small amounts of fission products. The proposed method also allowed the determination of ^{234}U in 1 mg of enriched uranium, with a relative error of ±0.52%. (auth)

Activation Procedures

Refer also to abstracts 40837, 40857, 41111, 41117, 41118, 42441, and 43181.

40578 (AD-679077) NUCLEAR APPLICATIONS PROGRAM. Progress Report, January 1–July 31, 1968. Wolicki, E. A. (Naval Research Lab., Washington, D. C.). Aug. 1968. 44p. (NRL-MR-1932). CFSTI.

A program of experiments in the application of nuclear techniques and facilities to problems in nonnuclear areas was initiated in the Nuclear Physics Division in January of 1968. The program consists of two parts: the analysis of materials using neutron or charged particle radioactivation or prompt radiation detection; and ion implantation of energetic heavy ions into solids. (auth) (USGRDR)

40579 (AERE-AM-109) DETERMINATION OF PRASEODYMIUM IN ZIRCON BY ABSORPTIOMETRIC AND RADIOACTIVATION METHODS. Spicer, G. S. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 9p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

In the absorptiometric method the zircon is decomposed by fusion with potassium hydrogen fluoride, praseodymium is separated as fluoride, which is then converted to the perchlorate, and the absorbancy is measured at 444 nm. In the alternative procedure the sample is subjected to neutron irradiation, decomposed as above, and the fluoride is converted to the oxalate for counting purposes after precipitation of the hydroxide. The methods can be applied to the analysis of zircons containing 1 to 10% praseodymium. Replicate determinations using the absorptiometric method gave a value of 2.25% for the praseodymium content of a zircon, and the coefficient of variation was 4.4%. Radioactivation gave a mean content of 2.23%, with a coefficient of variation of 4.5%. Lanthanum was present as an impurity at the 0.06% level. (auth) (UK)

40580 (CONF-670338, pp 91-101) APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS IN MINING, AGRICULTURE, MEDICINE AND CRIME INVESTIGATION. Guinn, Vincent P. (Gulf General Atomic, Inc., San Diego, Calif.).

A brief review is given on the uses of neutron activation analysis in mining, agriculture, medicine, and forensic science. These areas were selected as those having immediate interest and importance in many of the countries of Latin America. Sensitivity limits, analytical methods for use after activation, and elements of particular interest in the four areas are discussed. (P.C.H.)

40581 (GA-7688) WORLD-WIDE STATUS OF FORENSIC ACTIVATION ANALYSIS. Guinn, V. P.; Pinker, R. H. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 10, 1967. Contract AT(04-3)-167. 24p. (CONF-670223-1). Dep. CFSTI.

From 19th Annual Meeting of the American Academy of Forensic Sciences, Honolulu, Hawaii.

A summary of the papers presented at the First International Conference on Forensic Activation Analysis is presented. The present status and future prospects of forensic activation analysis are discussed. (D.H.M.)

40582 (RCN-106) DETERMINATION OF BROMINE IN WHEAT, FLOUR, AND BREAD BY NEUTRON ACTIVATION ANALYSIS. Das, H. A.; Hoede, D.; Zonderhuis, J. (Reactor Centrum Nederland, Petten). July 1969. 11p. Dep. CFSTI (U. S. Sales Only).

A routine method is presented for the determination of bromine in wheat and bread by thermal neutron activation analysis. The application to the determination of traces of bromine-containing germicides is discussed. (auth)

40583 ACTIVATION ANALYSIS VIA STATIC PROGRAMMING. Kovanic, P.; Slunecko, J. (Nuclear Research Inst., Prague). Atomkernenergie, 14: 249-53(July-Aug. 1969).

The method of static programming which is especially suitable for routine or repeated analyses and which reduces the proper analysis to minimum possible amount of basic arithmetic operations with best possible exploitation of the information is presented. The precondition of the applicability of this method is the linearity of the calculated estimates and the constant correlation matrices of the random components of the treated data. These preconditions are fulfilled if the weights of individual values of the spectrum are invariable, for which assumption both theoretical and practical reasons exist. The basic operation preceding the proper analysis of the spectra is their correcting for the spectrometer instability. The correction calculations are based on the exact calculation of the positions of some photopeaks in the spectrum. Measuring and necessary calculations are again carried out most economically. The given examples demonstrate that very good analytical results may be achieved even if the economical demands are respected. (auth)

40584 WHOLE-BODY NEUTRON ACTIVATION ANALYSIS. Chamberlain, M. J. (Birmingham Univ., Eng.). Proc. Roy. Soc. Med., 62: 370-2(Apr. 1969).

Whole-body assays of Na and Ca by activation analysis were investigated by neutron irradiation of phantoms, cadavers, and human volunteers. A uniform field of cyclotron-produced fast neutrons (mean energy ~3.5 MeV) was used, which was large enough to accommodate a whole body with a flux of 3×10^5 neutrons/cm^2 sec two meters from the source. After activation the subject was placed in a whole-body counter for counting of the induced radioactivity. It was necessary to provide some initial moderation of the fast neutrons, to achieve a uniform flux of slow neutrons throughout the body and to allow activation of Ca situated close to the body surface. In experiments with phantoms this initial moderation was supplied by a layer of polythene or paraffin wax placed in front of the phantom. Humans are placed in a polypropylene chamber, the 1.3-cm-thick walls of which provide initial moderation. It was shown that induced ^{49}Ca and ^{23}Na activity was proportional to the mass of the elements present in a phantom and to the dose of neutrons delivered to it, whether these were measured as fast neutrons with a BF$_3$ counter or as slow neutrons with shielded In foils, suitably placed at an arbitrary position in the neutron field. Measurement of Na and Ca in the human body could be achieved with radiation doses of ~0.1 RAD (1.0 Rem allowing a RBE value of 10 for fast neutrons). The radiation doses received by 3 volunteers were ~1300 mRem, compared with a dose of ~750 mRem for intravenous pyelography or a single radiograph of upper femur. (BBB)

40585 ELECTRON MICROSCOPIC FINDINGS AS WELL AS PHOTOMETRIC AND ACTIVATION ANALYTICAL RESULTS IN EXPERIMENTAL CARDIAC INSUFFICIENCY CAUSED BY COBALT CHLORIDE. Knieriem, H.-J.; Herbertz, G. (Univ., Duesseldorf). Virchows Arch., B, 2: 32-46(1969). (In German).

Neutron activation analysis was used to determine the Ca and Co content of myocardium of rats treated with Co. Repeated intraperitoneal injections of cobaltous chloride (single doses of 15 to 20 mg/kg up to a total dose of 40 to 240 m/kg body weight) in rats caused disseminated or even extensive necroses of the myocardium. Electron microscopic studies revealed severe swelling of mitochondria, dilatation of the sarcoplasmic reticulum and of the tubular system, disintegration of myofibrils, dehiscence of intercalated discs, and edema of endothelial cells. In addition, electron-dense particles measuring 0.2 to 0.4 μ were found within swollen mitochondria in animals receiving 200 to 240 mg CoCl$_2$/kg for 10 to 15 days. Intramitochondrial densities were also demonstrated in hepatic cells of the Co-treated animals. After the injections of CoCl$_2$ the content of Co was increased in the heart to 10 to 17 μg/g, in liver to 25 to 57 μg/g, and in kidney to 20 to 40 μg/g. The content of Co and Ca was determined in the mitochondria by activation analysis. After injection of CoCl$_2$ there was a significant shift in the Co/Ca ratio because Co accumulated in the myocardium and Ca was depleted. The intramitochondrial changes may be caused by the Co ions, and these changes may serve as signs of a so-called utilization insufficiency of the myocardium due to an inhibited utilization of high-energy phosphate from the loss of Ca ions. (BBB)

40586 DETERMINATION OF BORON IN SOLID BORON–ORGANIC COMPOUNDS BY INDIRECT NEUTRON ACTIVATION. Selecki, A.; Nowakowska, Z. (Warsaw Polytechnic). Radiochem. Radioanal. Lett., 1: 247-56(Aug. 13, 1969).

A method is described for the determination of boron in solid organic compounds and biological materials by means of a small 2×10^6 n sec^{-1} neutron source. The necessity for the separation of boron from its compounds is avoided. (auth)

40587 EXAMINATION OF AMBER SAMPLES BY NONDESTRUCTIVE ACTIVATION ANALYSIS. Das, H. A. (Reactor Centrum Nederland, Petten). Radiochem. Radioanal. Lett., 1: 289-95(Aug. 13, 1969).

Attempts were made to find a criterion for the origin of small amber samples, especially beads, which are often found during archeological excavations. A neutron activation method was elaborated which helps to distinguish between the northern, Baltic, and the southern, Sicilian, species. (auth)

40588 THE DETERMINATION OF VANADIUM IN PETROLEUM BY AN ACTIVATION METHOD WITH A NEUTRON GENERATOR. Blankova, T. N.; Rusyaev, V. G.; Bochkarev, B. N. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geol. Geofiz., No. 12, 108-11(Dec. 1968). (In Russian).

A neutron generator based on the bombardment of ^{2}H with ^{3}H is used to establish a new procedure for the determination of V in petroleum samples. With a neutron yield of 10^8 n/sec, a 50-g sample of petroleum is sufficient for analysis. The procedure requires determination of background for 5 min, irradiation of the unknown and a standard for 10 min in a paraffin block, a delay of 1 min 45 sec for decay of short-lived isotopes, counting the unknown for 9 min, and counting the standard for 1 min within 2 min of removal of the unknown. Calibration curves are illustrated, comparing data obtained by this method and spectral analysis, and correlating results obtained with V$_2$S$_5$ as a standard. The precision is 10% and sensitivity is 0.5×10^{-5} parts by mass. A single analysis requires 25 to 30 min. (BBB)

40589 ACTIVATION ANALYSIS OF OXYGEN BY HIGH-ENERGY NEUTRONS. Keller, K. A.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 12: 51-2(July 1969). (In German).

An investigation was made to determine whether determination limits for oxygen by neutron activation techniques are improved by the use of high-energy neutrons. Cellulose and boron oxide were analyzed and improved sensitivity was observed. (M.C.G.)

40590 RADIOCHEMICAL METHODS FOR THE DETERMINATION OF TRACE ELEMENTS IN NICKEL ALLOYS. PART II. DETERMINATION OF CHLORINE, PHOSPHORUS, AND SULPHUR. MacArthur, I. R.; Morris, D. F. C. (Brunel Univ., London). Metallurgia, 80: No. 477, 37-42(July 1969).

Neutron activation was applied to the determination of traces of chlorine, phosphorus, and sulphur in specially prepared samples of wrought nickel and nickel-base alloys. The nuclear reactions used were: for chlorine, ^{37}Cl(n,γ)^{38}Cl; for phosphorus, ^{31}P(n,γ)^{32}P; for sulphur, ^{32}S(n,p)^{32}P. In the determination of sulphur the reactor irradiations were performed with samples and comparators surrounded by cadmium. The radioactivation results for the concentration of sulphur in two specimens of nickel agreed closely with magnitudes obtained by other methods in several laboratories. (auth) (UK)

40591 NEW APPLICATIONS OF ACTIVATION ANALYSIS IN BIOCHEMISTRY. Rakovic, Miloslav (Karlova Univ., Prague). Chem. Listy, 63: 679-91(June 1969). (In Czech).

Elements present in small amounts or even in trace quantities play an important role in the animal and plant metabolic processes. Activation analysis presents many advantages for the determination of these elements because the method is very sensitive and the determination is nondestructive. Several metabolic processes, e.g., tumor formation, ion migration, metabolism of iodine, calcium, strontium, phosphorus, etc. may be conveniently examined by this method. Determination of the last three elements is used specifically for determining metabolic changes in bone tissues; determination of trace amounts of molybdenum and tungsten are useful for the study of plants. Neutrons and protons may be used for activation. The activation method is of great interest for all fields of life sciences. (TTT)

40592 RAPID DETERMINATION OF TUNGSTEN AND HAFNIUM IN PURE MOLYBDENUM. Leushkina, G. V.; Lobanov, E. M.; Dutov, A. G.; Matveeva, N. P. Zavod. Lab., 35: 715-17 (1969). (In Russian).

Rapid neutron activation methods for determination of tungsten and hafnium, using short-lived isotopes, in pure metallic molybdenum are described. The sensitivities of determination of 6×10^{-4}% W and 1×10^{-5}% Hf. The time required for analysis is approximately 2 min per specimen. (tr-auth)

40593 INSTRUMENTAL ACTIVATION ANALYSIS OF METEORITES USING GAMMA–GAMMA COINCIDENCE SPECTROMETRY. Ehmann, W. D.; McKown, D. M. (Univ. of Kentucky, Lexington). Anal. Lett., 2: 49-60(Jan. 1969).

A nondestructive procedure for the determination of iridium, sodium, nickel, cobalt, and scandium in a single meteorite sample is presented. The method utilizes neutron activation followed by gamma-gamma coincidence spectrometry. Iridium abundances are given for several meteorites and compared to values obtained by radiochemical separation methods. The nondestructive results differ significantly from previously published values for certain classes of meteorites, in particular the enstatite chondrites. (auth)

40594 SIMULTANEOUS DETERMINATION OF PALLADIUM, PLANTINUM, AND RHODIUM IN CRUDE PLATINUM SAMPLES BY ACTIVATION ANALYSIS AND HIGH-RESOLUTION GAMMA SPECTROMETRY. Turkstra, J.; de Wet, W. J. (Atomic Energy Board, Pelindaba, South Africa). Talanta, 16: 1137-43(Aug. 1969).

Instrumental neutron-activation analysis using a Ge(Li) detector was investigated for the simultaneous determination of platinum, palladium, and rhodium in crude platinum samples contained in lead cupels. This technique proved feasible and appears promising for extension to the determination of most of the noble metals. (auth) (UK)

40595 NEUTRON ACTIVATION ANALYSIS. Petersen, B. Riber (Danish Isotope Center, Copenhagen). Forsk. Udvikling-Uddannelse, 78: 122-6(1969). (In Danish).

The principles of neutron activation analysis are described. When a specimen is irradiated with neutrons, the most important nuclear reaction for the analysis is the capture of a neutron by a nucleus. In a great number of cases the isotopes thus formed will be radioactive, and by measurement of the radiation the elements of the specimen may be identified and their quantities determined. The method may be applied to approximately 70 elements with a sensitivity of $10^{-6}-10^{-13}$ g. (UK)

40596 ROUTINE DETERMINATION OF CHROMIUM IN ROCKS. Das, H. A.; Hoede, D.; Zonderhuis, J. (Reactor Centrum Nederland, Petten). Radiochem. Radioanal. Lett., 1: 365-72(Aug. 25, 1969).

Solvent extraction is used as a separation method in the determination of chromium in rocks by neutron activation analysis. (auth)

40597 THE DETERMINATION OF Hf/Zr RATIO IN VARIOUS SOUTH AFRICAN ZIRCONS BY MEANS OF HIGH-RESOLUTION γ SPECTROMETRY. Turkstra, J.; De Wet, W. J. (Atomic Energy Board, Pretoria). J. S. Afr. Chem. Inst., 22: 43-9(Jan. 1969).

The most appropriate choice of selected photopeaks for determination of Hf and Zr simultaneously in South African zircons was found to be the 0.482-MeV and the 0.665-MeV photopeaks of ^{181}Hf and ^{97}Nb, in equilibrium with ^{97}Zr, respectively. The sensitivity for Zr determination when using ^{96}Zr is not satisfactory unless very long irradiations are done. In some cases, when the rare earth concentration in Zr minerals is above 2% the photopeak of ^{140}La (0.490 MeV) influences the photopeak of ^{181}Hf (0.482 MeV). Irradiations of 100-mg samples were done in the hydraulic facility of Safari-1, an ORR-type reactor, in a thermal neutron flux of $\sim 2 \times 10^{13}$n cm^{-2} sec^{-1}. After a cooling time of about 66 hr the samples were placed 6 cm below a Ge(Li) detector. The mean values for the various zircon samples were compared with the corresponding values given by Schutte, who used a chemical separation method followed by x-ray emission spectrography. The lower new results could be due to the superior specificity of the activation analysis method. The overall error of this technique is ~7.9%. In comparison with other analytical methods the present technique can be applied with considerable advantage to samples of various Zr minerals, and may perhaps be extended to whole rock samples. (BBB)

40598 TRACE SILVER DETECTION IN PRECIPITATION BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Warburton, Joseph A. (Desert Research Inst., Reno, Nev.). J. Appl. Meteorol., 8: 464-6(June 1969).

Atomic absorption spectrophotometry and neutron activation analysis were used to determine the silver content in precipitation in locations where silver iodide seeding had occurred. The mean concentration of Ag in snow was found to be $1.1 \pm 0.2 \times 10^{-9}$ g/ml by the atomic absorption method and $1.3 \pm 0.1 \times 10^{-9}$ g/ml by the neutron activation method. (D.H.M.)

40599 A QUALITATIVE AND COMPARATIVE STUDY OF ELEMENTS IN TEETH BY NEUTRON ACTIVATION AND HIGH-RESOLUTION GAMMA SPECTROMETRY. Retief, D. H. (Univ. of the Witwatersrand, Johannesburg); Van Wyk, C. W.; Turkstra, J. J. Dent. Ass. S. Afr., 24: 75-80(Mar. 1969).

The teeth to be analyzed were sealed in polyethylene tubes for short irradiation, or in quartz ampoules for long irradiation. For the detection of short-lived radioisotopes, each tooth in its polyethylene container was irradiated for 1 min in the pneumatic facility of the nuclear reactor Safari I in a thermal neutron flux of 1×10^{13} n/cm^2/sec, and the γ activity of the sample was determined after 2 min. The long-lived radioisotopes were detected after a decay period of 3 weeks after irradiation of the teeth in the poolside facility of Safari I for 50 to 100 hr in a flux of 2×10^{13} n/cm^2/sec. In the 36 teeth analyzed, Sr, Zn, Br, Mn, Cu, Na, Cl, Ca, Fe, Co, and Sb were identified. Typical γ spectra obtained from teeth subjected to short or long irradiation are shown. The results confirmed that neutron activation followed by high-resolution γ spectrometry is a sensitive method for the qualitative analysis of some elements in teeth. One anticipated advantage of this nondestructive analytical method did not materialize as the teeth disintegrated when they were irradiated for long periods. (BBB)

40600 NEUTRON ACTIVATION AND HIGH RESOLUTION GAMMA SPECTROMETRY: ACTIVATION ANALYSIS. Retief, D. H. (Univ. of the Witwatersrand, Johannesburg); Van Wyk, C. W.; Turkstra, J. J. Dent. Ass. S. Afr., 24: 69-75(Mar. 1969).

Fundamentals of neutron activation analysis, counting equipment, and advantages, limitations, and applications of the method are reviewed. Activation by particles other than neutrons is also considered. The most efficient charged particles for activation are deuterons and tritons, but protons and α particles may be used. The nuclear reactions involved are listed. Practical steps in activation analysis are outlined. Activation analysis is the most sensitive analytical method available for many elements, and is also a relatively rapid method, even if chemical separation has to be carried out. Reactions other than the (n,γ) reaction are considered as basis of activation analysis. The inherent high sensitivity of neutron activation for many elements makes it extremely suitable for the determination of trace amounts. (BBB)

40601 DETERMINATION OF RARE EARTH ELEMENTS IN HOT SPRING WATERS. 3. ACTIVATION METHOD IN COMBINATION WITH ION EXCHANGE SEPARATION METHOD. Oda, Toshiyuki (Kyushu Univ., Fukuoka). Onken Kiyo, 20: No. 3, 205-13(Sept. 1968). (In Japanese).

Lanthanum, Sm, Eu and Sc were determined in some hot spring waters, such as Yunotsu and Ikeda. The rare earth elements were coprecipitated with Ca oxalate from 10 liters of spring waters and ignited carefully. The precipitates were irradiated in the K.U.R. for 5 hr at a neutron flux of 2×10^{13} n/cm^2/sec and the rare earths separated radiochemically by an ion-exchange method, using 0.5M, pH 3.5, ammonium citrate as an elutant. The radioactivity was measured with the 512 channel pulse height analyzer. The contents of the rare earths in the analyzed waters were in the range of 0.08 to 0.13 μg/liter for La, 0.02 to 0.07 μg/liter for Sm, 0.005 to 0.008 μg/liter for Eu, and 0.4 to 0.8 μg/liter for Sc, respectively. (NSA of Japan)

40602 DETERMINATION OF MICROGRAM AMOUNTS OF MERCURY IN HOT SPRING WATER BY NEUTRON ACTIVATION ANALYSIS. Kawakami, Hiroyasu (Kyushu Univ., Fukuoka). Onken Kiyo, 20: No. 3, 226-33(Sept. 1968). (In Japanese).

The Hg was prepared for irradiation by dithizone-$CHCl_3$ extraction. After evaporation and redissolution, the Hg-dithizone was adsorbed on filter paper, and filter paper and standard were sealed in separate polyethylene envelopes for irradiation. Irradiation was carried out at a neutron flux of 2.1×10^{12} n/cm^2/sec for 5 hr, and the samples were cooled for 5 days. All samples were counted by a Hitachi 400 channel pulse height analyzer (1¾" × 1", NaI crystal, well-type). The highest sensitivity for Hg was obtained by counting the 0.0776-MeV γ rays from ^{197}Hg. The calibration curve was linear in the 0.5 to 20 μg Hg range with about 1.6×10^4 cpm/μ of Hg. The Hg content was determined from the calibration curve covering the range of 0.5 to 20 μg of Hg. The relative error at the 95% confidence limits was about ±5%. The lowest limit of the method was approximately 0.25 ppB. (NSA of Japan)

40603 DETERMINATION OF MERCURY IN HUMAN HAIR BY NEUTRON ACTIVATION ANALYSIS. Kawakami, Hiroyasu (Kyushu Univ.. Fukuoka). Onken Kiyo, 20: No. 3, 218-25 (Sept. 1968). (In Japanese).

Cleaned, dried samples of hair and standard samples of Hg absorbed on filter paper were sealed in separate polyethylene envelopes, packed together in an irradiation capsule, and irradiated for 5 hr at a neutron flux of 2.1×10^{10} n/cm^2/sec. After cooling for 3 to 5 days mercuric nitrate containing 80 mg of Hg as a carrier was added to the standard sample; the mixture was decomposed with concentrated HNO_3 and H_2O_2; and then treated with concentrated $(NH_4)_2S$ to precipitate the Hg as HgS, which was separated and dried. Using an Al absorber with 1.5 mm thick, the hair sample and the prepared standard sample were measured by a Hitachi 400 channel pulse height analyzer. The highest sensitivity for Hg was obtained by counting the 0.0776-MeV γ rays from ^{197}Hg. The relative error at the 95% confidence limits was about ±5%. The lowest value to be detected by the method was approximately 0.5 ppM. (TSS)

40604 ACTIVATION ANALYSIS FOR MERCURY IN BIOLOGICAL SAMPLES AT NANOGRAM LEVEL. Kosta, L.; Byrne, A. R. (Univ. of Ljubljana, Yugoslavia. Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Talanta, 16: 1297-1303(Sept. 1969).

A new method was devised for determining mercury in samples of biological origin. It is based on complete ignition of the reactor-irradiated sample in a silica tube, trapping volatile interfering activities such as bromine or chlorine, and selectively adsorbing mercury on a strip of filter paper, which was previously impregnated with elemental selenium. This strip is later counted, for quantitative evaluation, based on ^{197}Hg. The versatility of the method was demonstrated by the analysis of a wide range of samples such as water, cellulose, flour, fish solubles, or animal blood with mercury contents between 1 and 200 ng/g of sample. (auth) (UK)

40605 DETERMINATION OF PHOSPHATE IN NATURAL WATERS BY ACTIVATION ANALYSIS OF TUNGSTOPHOSPHORIC ACID. Allen, Herbert E. (Bureau of Commercial Fisheries, Ann Arbor, Mich.); Hahn, Richard B. Environ. Sci. Technol., 3: 844-8(Sept. 1969).

Activation analysis may be used to determine quantitatively traces of phosphate in natural waters. Methods based on the reaction $^{31}P(n,\gamma)^{32}P$ are subject to interference by sulfur and chlorine which give rise to ^{32}P through (n,p) and (n,α) reactions. If the ratio of phosphorus to sulfur or chlorine is small, as it is in most natural waters, accurate analyses by these methods are difficult to achieve. In the activation analysis method, molybdate and tungstate ions are added to samples containing phosphate ion to form tungstomolybdophosphoric acid. The complex is extracted with 2,6-dimethyl-4-heptanone. After activation of an aliquot of the organic phase for 1 hr at a flux of 10^{13} neutrons per cm^2 per second, the gamma spectrum is essentially that of tungsten-187. The induced activity is proportional to the concentration of phosphate in the sample. A test of the method showed it to give accurate results at concentrations of 4 to at least 200 ppB of phosphorus when an aliquot of 100 μl was activated. By suitable reagent purification, counting for longer times, and activation of larger aliquots, the detection limit could be lowered several hundredfold. (auth)

40606 APPLICATION OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF IMPURITIES IN TELECOMMUNICATION MATERIALS. Bogancs, Janos (MTA Koezponti Fizikai Kutato Intezet, Budapest); Cseh, Sandor; Elek, Antal; Sali, Sandor; Simonits, Andras; Oerdoegh, Maria; Szabo, Elek. Atomtech. Tajek., 11: 631-4(Dec. 1968). (In Hungarian).

The analytical activation methods elaborated in the Activation Analytical Laboratory of the Central Research Institute for Physics for the analysis of telecommunication materials are described. The materials investigated were: silicon used mainly in the production of semiconductors, gallium arsenide, clean chemicals, as well as distilled water, tungsten, nickel, gold, yttrium, zinc sulfide, zirconium, and thorium oxide. The application of the described methods resulted in considerable savings. (auth)

40607 DETERMINATION OF Si, Cl, K, P, Ca, AND Al IN BIOLOGICAL MATERIALS BY ACTIVATION ANALYSIS USING 14-MeV NEUTRONS. Schramel, P. (Gesellschaft fuer Strahlenforschung, Neuherberg, Ger.). J. Radioanal. Chem., 3: 29-36 (July 1969). (In German).

A neutron activation analysis procedure utilizing 14-MeV neutrons produced by an accelerator is described. Si, Cl, K, P, Ca, and Al were determined in biological material without any chemical separation. In order to avoid interpretation of very complex spectra, the half-life of the nuclides was applied for the measurement as an important characteristic. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 40713, 40747, 40797, 40802, 40828, 40834, 41530, 41606, 41609, 41729, 42495, and 43134.

40608 (CALT-767-P-4-47) REACTIVE COLLISIONS. Kuppermann, Aron (California Inst. of Tech., Pasadena. Arthur A. Noyes Lab. of Chemical Physics. Weizmann Inst. of Science, Rehovoth (Israel)). [1968]. Contract AT(04-3)-767. 30p. Dep. CFSTI.

The present state of a priori calculations of chemical reaction cross sections is reviewed, with emphasis on the hydrogen atom plus hydrogen molecule reaction. Some comparisons with experiments are included. (auth)

40609 (CEA-N-1044, pp 81-92) ELECTROCHEMISTRY STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Electrochemical studies were made on: the deposition of W from fused fluoride salts; transport properties of Ag^+ and Cl^- in fused chloride salts; deposition of nickel at high temperature under pressure; deposition of gold on Al–brass and Cu–Ni alloys; and the diffusion of hydrogen in carbon steel under stress. (P.C.H.)

40610 (CEA-N-1044, pp 331-80) FUNDAMENTAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Developments are reported for studies on: reactions of rare earths and trivalent transuranium elements in HCl solutions; oxidation-reduction of Np(V) in perchloric acid solutions; mechanism of formation of precipitates of low soluble salts; liquid–liquid extraction in pulsed columns; transient behavior in mixer settlers; use of the adder–subtracter of the multiparameter analysis assembly for $\gamma-\gamma$ coincidence experiments; use of an electronic assembly for α and β spectrometry assembly; and determination of ^{236}Pu in ^{238}Pu. (P.C.H.)

40611 (CEA-R-3555) CONTRIBUTION TO MEASUREMENT OF THE REFLECTION COEFFICIENT OF CURVED CRYSTALS BETWEEN 50 AND 80 keV. Chartier, Jean-Louis (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1968. 87p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, France.

The main approximate theories dealing with the diffraction of electromagnetic radiation by the crystalline medium, allowing the determination of the characteristic properties of flat and bent crystals used in x and γ spectroscopy ("Laue Case") are summarized. The experimental set-up is described, and a method for measuring Γ: reflectivity of elastically or plastically bent-crystals from narrow wave-length intervals in the continuous x-ray spectrum, is described. The experimental results obtained with different crystals (quartz (31$\bar{4}$0), Al (200), FLi (200)) are described and compared with theoretical ones. Finally, use of the bent-crystal spectrometer (CAUCHOIS arrangement) in dosimetry is discussed. (auth)

40612 (CEA-R-3803) BEHAVIOR OF TRIVALENT ACTINIDES AND LANTHANIDE ELEMENTS IN CHLORIDE SOLUTION. Marin, Bernard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1969. 128p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

The complexing ability of trivalent lanthanides and actinides in chloride solutions was compared. Studies were also made on the solvation of these cations with complexing. A difference was found between Am, Cm, and rare earths (rare earths are separated into light and heavy elements). Paper electrophoresis was used for studying the complexation after a simple theory of mobilities in complex solutions was established. The hydrolysis of these cations was studied and compared in chloride solutions. Complexation with the Cl^- ligand was studied in HCl, NH_4Cl, $CaCl_2$, $CeCl_3$, and LiCl solutions. It was established that the complexation is the same in dilute HCl solutions but in concentrated solutions the trivalent actinides are more complexed. This difference is sharper in LiCl solutions. Different models for complexing in these solutions are proposed. (55 references). (auth)

40613 (COO-1054-44) LUMINESCENCE IN CALCIUM TUNGSTATE. Double, Glen P. (Wayne State Univ., Detroit, Mich.). Sept. 1968. 31p. Dep. CFSTI.

Thesis.

Luminescence in calcium tungstate was investigated experimentally as a function of temperature and of wavelength. It was found that the thermoluminescence peaks appear at different wavelengths, indicating more than one luminescence center. A new model for luminescence in calcium tungstate is proposed in which a configuration coordinate diagram is used for each different type of luminescence center. (auth)

40614 (K-1753) LIQUID BROMINE PENTAFLUORIDE RELEASE TESTS. Habiger, K. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 13, 1969. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Liquid bromine pentafluoride was considered for use as the uranium fluorinating agent in fluoride volatility processes for recovering values from irradiated fuel. Since bromine pentafluoride is extremely reactive, it was felt that a testing program should be undertaken to determine the resistance to attack and/or vigorousness of reaction when materials typical of those that might be present in a fluoride volatility plant are contacted with bromine pentafluoride. The tests were not intended to evaluate corrosion resistance of materials routinely exposed to bromine pentafluoride, however. The tests showed that, in general, almost all organic materials, including conventional protective clothing and equipment, react violently with liquid bromine pentafluoride. Residual explosive compounds may be formed as demonstrated in one test with a heat transfer cement. All of the metals tested were essentially inert to reaction with liquid bromine pentafluoride at room temperatures, as were metal fluorides, Transite, alumina, Teflon, and Kel-F. Foam type insulations, loose webbed materials, and fine powders or dusts appeared to be particularly susceptible to reaction with liquid bromine pentafluoride. (auth)

40615 (NP-tr-1828) EXPERIMENTS ON THE CHEMISTRY OF ELEMENT 104, KURCHATOVIUM. III. CHEMICAL EQUIPMENT IN A CYCLOTRON BEAM. Chuburkov, Yu. T.; Zvara, I.; Shilov, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translated by R. G. P. Towndrow (Atomic Energy Research Establishment, Harwell, Eng.), from report JINR-P7-4021. 32p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 22: 48848. (W.H.K.)

40616 (UCRL-18735, pp.5-80) CHEMISTRY. (California Univ., Berkeley. Lawrence Radiation Lab.).

Research in chemistry is reported under the following headings: inorganic chemistry, chemical thermodynamics, solid-state chemistry and physics, electrochemistry, physical chemistry, and nuclear science. (M.C.G.)

40617 SPECTROPHOTOMETRIC STUDY OF THE COMPLEXING OF Am^{3+} WITH AMINOPOLYACETIC ACIDS. Delle Site, A.; Baybarz, R. D. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 31: 2201-33(July 1969).

Eight aminopolyacetic acids, varying in size from iminodiacetic to tetraethylenepentaamineheptaacetic, were studied with respect to their complexation with trivalent americium. The compositions and pH ranges of stability of 22 complexes were determined using an absorption spectrophotometric technique. Instability constants were calculated for 13 of these complexes. The data obtained were compared with published data for americium and for the lanthanides. (auth) (UK)

40618 ABSORPTION SPECTRUM OF AMERICIUM TRICYCLOPENTADIENIDE. Pappalardo, R.; Carnall, W. T.; Fields, P. R. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 842-3(July 15, 1969).

The absorption spectra of thin films of an Am(III) pseudohalide, the tricyclopentadienide, were studied. The absorption groups showed a bathochromic shift even with respect to AmI_3. This was in line with the increased covalency and volatility of the pseudohalide. Generally the splitting within a general group was quite pronounced. The $^7F_0 \rightarrow {}^7F_2$ transition at ~5000 cm^{-1} was relatively much stronger than all the remaining transitions. (M.C.G.)

40619 ANOMALOUS H–D ISOTOPE EFFECTS IN CUBIC METABORIC ACID. Schwarzmann, Einhard; Christoph, Geert (Univ., Goettingen, Ger.). Z. Naturforsch., 24b: 965-7(Aug. 1969). (In German).

An anomalous H-D isotope effect prevents the formation of γ-DBO_2 in cubic metaboric acid by the method of preparation of γ-HDO_2. Instead, β-DBO_2 is formed, which possesses a basically different crystal structure. However, γ-DBO_2 can be synthesized under changed conditions. This anomalous behavior is explained on the basis of a varying density of H and D in centers of a double minimum potential for hydrogen bonding. (tr-auth)

40620 DEUTERIUM ISOTOPE EFFECT IN PROTON MAGNETIC RESONANCE SPECTRA OF 3-HYDROXY-2-BUTANONE (SHORT COMMUNICATION). Marsman, J. W.; Lubach, J.; Drenth, W. (Inst. for Organic Chemistry, Utrecht). Rec. Trav. Chim., 88: 193-4(Feb. 1969).

In a study on the oxidation of 3-hydroxy-2-butanone (acetoin) the rate of its enolization in acidic aqueous solution was determined. The rate was estimated by following the proton magnetic resonance spectrum when acetoin was dissolved in 2N $D_2SO_4-D_2O$. Except for the hydroxyl hydrogen, the 4-butanone hydrogens (position c) were deurated faster than the 2-butanone hydrogen (position a), while the 1-butanone hydrogens (position b) were deuterated at the lowest rate. In the 100-MHz spectrum of acetoin the coupling constant $J_{H-C-C-H} = 7.2 \pm 0.1$ Hz and the shift between the quartet signal of a and the doublet signal of b amounts to $\delta = 304$ Hz. Thus $J/\delta = 0.024$, with a near ideal A_3X spectrum. Because of partial deuteration in position a, the original doublet of hydrogen b in the proton magnetic resonance spectrum of acetoin is accompanied by a broadened singlet. This singlet does not coincide with the center of the doublet, but is shifted over 0.8 ± 0.1 Hz to higher field. In the same way, because of partial deuteration of CH_3(b) to CH_2D the remaining signal of hydrogen a appears as a quartet and a slightly broadened triplet. After heating for 3 hr at 65°C, exchange in position b is about 25%. In this case again, the centers of the quartet and triplet do not coincide. The shift amounts to 0.5 ± 0.1 Hz to higher field. (BBB)

40621 STUDY OF THE SECONDARY ISOTOPE EFFECT OF DEUTERIUM IN THE COMPOSITION OF THE BISULFITE COMBINATION OF 4-tert-BUTYLCYCLOHEXANONE: CONFORMATION ENERGY OF THE SO_3^- GROUP. Lamaty, G.; Roque, J. P. (Faculte des Sciences, Montpellier, France). Rec. Trav. Chim. 88: 131-8(Feb. 1969). (In French).

A study of the secondary isotope effects for the formation and degradation reactions of hydroxysulfonates of aliphatic and cyclic ketones revealed that the k_H/k_D ratio varies from one ketone to another and that the variations can be interpreted on the basis of the hyperconjugative effects in the ketone and the transition state. The rate constants for the hydrolysis of the bisulfite addition compounds of cyclohexanone, 4-tert-butylcyclohexanone, and their α-deuterated homologues were measured. There was a large difference between the isotope effects observed for the cyclohexanone ($k_H/k_D = 1.10$) and the "slow" isomer from the 4-tert-butylcyclohexanone ($-SO_3^-$ equatorial; $k_H/k_D = 1.05$). This result is discussed in terms of the existing difference between the geometries of the transition states. The conformational energy of the $-SO_3^-$ group was determined and found to be equal to 2.25 kcal/mole. (BBB)

40622 COOLANT SALT FOR A MOLTEN SALT BREEDER REACTOR. Thoma, R. E.; Hebert, G. M. (to United States Atomic Energy Commission). U. S. Patent 3,448,054. June 3, 1969.

A ternary molten fluoride salt composition, $NaF-KF-BF_3$, was found to be suitable as a secondary coolant salt and/or heat transfer fluid for a breeder-type molten salt reactor. (AEC)

40623 STUDIES ON HYDROGEN EXCHANGE. VI. THE BASE-CATALYZED HYDROGEN EXCHANGE OF ALPHA-HYDROGENS IN ALKYL GROUPS SUBSTITUTED ON SOME NITROGEN-CONTAINING HETEROAROMATIC RINGS. Kawazoe, Yutaka; Ohnishi, Masako; Yoshioka, Yuko (National Cancer Research Inst., Tokyo). Chem. Pharm. Bull. (Tokyo), 15: 1225-31 (Aug. 1967).

Hydrogen–deuterium exchange of α-hydrogens of the side-chain alkyl groups substituted in pyridine, quinoline, isoquinoline, their N-oxides, and N-alkyl halides was studied and the electronic effect of the nitrogen function in these heteroaromatic nuclei was considered. α-Hydrogens of alkyl groups substituted in electron-deficient aromatic rings can be expected to undergo a base-catalyzed deuterium exchange reaction more easily than methyl hydrogens in toluene. This type of hydrogen exchange can be considered to be initiated by a nucleophilic attack of a base ion or molecule on hydrogen, resulting in heterolytic (protolytic) cleavage of C–H bond to yield a carbanion and a proton, just as in the dissociation process of conventional acid molecules. Hydrogen–deuterium exchanges were carried out by heating the neutral or alkaline deuterium oxide solutions (with 1% NaOD or 1% Na_2CO_3) of the 33 compounds examined. The conditions (temperature and time) under which D exchange began and was completed are tabulated for each of the 33 compounds. (BBB)

40624 THE BINDING OF ^{141}Ce, ^{106}Ru, ^{137}Cs, AND ^{65}Zn WITH HYDROPHILIC HIGH MOLECULAR WEIGHT COMPOUNDS DISSOLVED IN SEA WATER. Parchevskii, V. P.; Khailov, K. M. Okeanologiya, 8: 1092(1968). (In Russian).

Hydrophilic organic compounds with molecular weights above 50,000 were separated by emulsion extraction and gel filtration from foams collected from the Barents Sea in a region with minimal anthropogenic contamination. The organic samples were dissolved in seawater into which small amounts of the chlorides of ^{141}Ce, ^{106}Ru, ^{137}Cs, and ^{65}Zn had been added. After a day aliquots were chromatographed on neutral Sephadex G-75 to separate macromolecules with bound metal from the free metal ions. Samples were analyzed with a multichannel analyzer and a NaI(Te) crystal. The γ spectral analysis indicated that the isotopes ^{141}Ce, ^{106}Ru, and ^{65}Zn were bound to the macromolecular compound to a significant extent. Within the limits of sensitivity of the method employed, ^{137}Cs did not appear to form complexes with the macromolecular compounds used. (BBB)

40625 SECONDARY ISOTOPE EFFECTS. PART IV. COMPLEX FORMATION BETWEEN AROMATIC HYDROCARBONS AND HCl. Halevi, E. A.; Ravid, B. (Technion–Israel Inst. of Tech., Haifa). Israel J. Chem., 6: 723-33(Sept.-Oct. 1968).

The isotope effects on complex formation between HCl and variously deuterated benzenes and toluenes were measured at −80°C, using a differential solubility technique. Both methyl and nuclear deuteration increased the basicity of the hydrocarbon, the 2 effects being additive in toluene. If the total isotope effect on the standard free energy of complex formation, in any isotopic pair, is given by $\delta\Delta F^0 = m(\delta\Delta F_M) + n(\delta\Delta F_N)$, where m and n respectively represent the number of excess methyl and nuclear deuterium atoms in the heavy molecule, treatment of all experimental results yielded, for 193°K: $\delta\Delta F_N = -3.1_5^-$ cal g/atom nuclear D; $\delta\Delta F_M = -3.5_6^-$ cal g/atom methyl D. Thus nuclear and side-chain deuterations both increased hydrocarbon basicity towards HCl, and did so to a quantitatively similar extent. The origin of the 2 effects is sufficiently different that they are discussed separately. The greater basicity of methyl-deuterated toluene towards HCl is another instance of the inductive effect of deuterium. The general phenomenon of greater apparent electron accession to the side-chain in the deuterated compounds is accompanied by specific, and not easily explicable, variations in the effect of deuteration at different nuclear positions. (BBB)

40626 INVESTIGATION OF THE REACTIONS OF SOLUTIONS OF THORIUM NITRATE AND ALKALI METAL CARBONATES BY THE METHODS OF HIGH-FREQUENCY AND pH TITRATION. Nguyen Ting Ngo; Martynenko, L. I. (Moscow State Univ.). Zh. Neorg. Khim., 14: 1541-5(June 1969). (In Russian).

Measurements of the magnitude of the pH and electric conductivity of solutions, obtained by mixing solutions of thorium nitrate and alkali metal carbonates in direct and reverse order, showed that basic thorium carbonates are formed. Interpretation of the curve of high-frequency titration is facilitated if the change in concentration of hydrogen ions in the titrated solutions is considered simultaneously. (tr-auth)

40627 LIFETIMES AND TOTAL TRANSITION PROBABILITIES FOR NH, SiH, AND SiD. Smith, Wm. Hayden (Princeton Univ., N. J.). J. Chem. Phys., 51: 520-4(July 15, 1969).

Radiative lifetimes were measured for the NH (d $^1\Sigma-$c $^1\Pi$), (c $^1\Pi-$a $^1\Delta$), (c $^1\Pi-$b $^1\Sigma$), and (A $^3\Pi-$X $^3\Sigma$) systems, and for the SiD and SiH (A $^2\Delta-$X $^2\Pi$) transitions. The phase-shift technique yielded lifetimes ranging from 10 nsec for the NH (d $^1\Sigma-$c $^1\Pi$) transition to 700 nsec for the SiH (A $^2\Delta-$X $^2\Pi$) band. All the lifetimes of upper states measured showed the effects of radiative cascading. In particular, the c $^1\Pi$ state of NH shows radiative cascading originating at least in part from the observed d $^1\Sigma$ state. The measured d $^1\Sigma$ state lifetime is near the nominal lifetime computed for the state cascading into the c $^1\Pi$ state and is considerably shorter than the c $^1\Pi$ state lifetime. The NH (A $^3\Pi-$X $^3\Sigma$) and the SiD and SiH (A $^2\Delta-$X $^2\Pi$) transitions showed cascading that arises from states that were not spectroscopically identified. All the systems studied, with the exception of the NH (d $^1\Sigma-$c $^1\Pi$) transition, showed cascading in which the cascading state lifetime was shorter than the measured state lifetime. Consideration is given as to the effects on measured phase shifts and calculated radiative lifetimes. (auth)

40628 CONCERNING THE REACTIONS OF UO_2 AND MoO_3 IN MOLTEN NaF–LiF EUTECTIC. Galkin, N. P.; Vlasov, A. D.; Birin, E. A.; Kozlov, A. M. Zh. Neorg. Khim., 14: 1631-3(June 1969). (In Russian).

The method of solubility was used to study the reactions of UO_2 with MoO_3 in molten NaF–LiF at 700 to 1000°C. An equation for the dissolution reaction is proposed. The constants for the reaction at different temperatures were determined. (tr-auth)

40629 FLUORO AND CHLOROFLUORO COMPLEXES OF PENTAVALENT PROTACTINIUM. Plaisance, M.; Guillaumont, R. (Institut de Physique Nucleaire, Val de Marne, France). Radiochim. Acta, 12: 32-7(July 1969). (In French).

In aqueous solutions of HF concentrations of $>10^{-3}$ $\underline{M}$, pentavalent protactinium formed at the following two complexes: PaF_7^{2-} and $HPaF_7^-$. In the presence of F^-- and H^+-ions Pa(V) tended to form mixed complexes. Under the conditions $[F^-] = 8 \times 10^{-3}$ $\underline{M}$ and $[Cl^-] = 1\underline{M}$ the existence of PaF_7Cl^{3-} was established at pH values ranging from 2 to 7. The molar extinction coefficient of this chlorofluoro complex is 1.3×10^3 mole^{-1} 1 cm^{-1} at 207 mμ. These results were obtained by means of absorption spectrometry, potentiometry, and anion exchange technique. (auth)

40630 MOESSBAUER SPECTROSCOPIC STUDY OF THE CHEMICAL STATE OF TIN AFTER (n,γ) REACTION IN TIN OXIDES. Yoshida, Hiroyuki; Herber, R. H. (Rutgers-The State Univ., New Brunswick, N. J.). Radiochim. Acta, 12: 14-17 (July 1969). (NYO-2472-54).

Moessbauer effect experiments were carried out on neutron-irradiated ^{118}SnO and ^{118}SnO$_2$ in order to determine whether charge states other than those of the parent atom can be stabilized in these lattices. Mirror experiments in which the same chemical form can be used both as a Moessbauer source and absorber showed that no anomalous charge states or chemical compounds can be detected in stannic oxide matrices. Irradiated ^{118}SnO shows a small (~5%) resonance ascribed to SnO_2, but this is formed under the irradiation conditions in the stannous oxide lattice rather than being due to the chemical consequences of the isomeric decay preceding the Moessbauer transition in ^{119}Sn. (auth)

40631 CHEMICAL EFFECTS ASSOCIATED WITH β^- EMISSION. III. STUDY OF ^{99m}Tc FORMED BY β^- DISINTEGRATION OF ^{99}Mo. Ferradini, C.; Carlier, R.; Genet, M.; Pucheault, J. (Institut de Physique Nucleaire, Paris). Radiochim. Acta, 12: 1-4(July 1969). (In French).

The chemical consequences of β^- disintegration were studied with the $^{99}\mathrm{Mo} \xrightarrow{\beta^-} {}^{99m}\mathrm{Tc}$ system. With varying conditions of acidity, presence or absence of carriers (Tc^{IV}, Tc^{VII}) or of dissolved oxygen, the technetium was always found in its highest oxidation state, Tc(VII). (auth)

40632 CRYSTAL CHEMISTRY OF RADIUM. IV. RADIUM SULFIDE AND SELENIDE. Weigel, F.; Trinkl, A. (Univ., Munich. Technische Hochschule, Munich). Radiochim. Acta, 12: 29-31(July 1969). (In German).

Radium sulfide, RaS, and radium selenide, RaSe, were prepared by high vacuum reduction of radium sulfate at 990°C and radium selenate at 950°C, respectively, using carbon powder as the reductant, and an iridium crucible as container for the reaction mixture. RaS and RaSe crystallized in a cubic face-centered NaCl-type lattice, space group O_h^5-Fm3m, having 4 formula units per unit cell and the following lattice constants: RaS: $a_0 = 6.575$ Å, RaSe: $a_0 = 6.80$ Å. The calculated densities were found to be 6.03 gcm^{-3} for RaS, and 6.43 gcm^{-3} for RaSe. RaS and RaSe are isomorphous with the corresponding barium compounds. (auth)

40633 THE THIRD SPECTRUM OF PRASEODYMIUM (Pr III) IN THE VACUUM ULTRAVIOLET. Sugar, Jack (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 73A: 333-81(May-June 1969).

Measurements of the spectrum of doubly ionized praseodymium from 821 to 2103 Å are given. One hundred fifty-three energy levels deduced from these wavelengths and an earlier line-list of longer wavelengths are presented. These levels are identified with the configurations $4f^26s$, $4f^27s$, $4f^28s$, $4f^26p$, $4f^26d$, $4f^25f$, $5d^24f$, and 4f5d6s and are given term designations. Radial energy integrals belonging to these configurations are parametrically deduced from the known levels. A value of 21.625 eV (174420 cm^{-1}) for the ionization energy of Pr III, with an estimated uncertainty of 0.016 eV (130 cm^{-1}), is derived from the $4f^2ns$ series (n = 6, 7, 8). (auth)

40634 ARRHENIUS PARAMETERS FOR THE ABSTRACTION REACTIONS OF METHYL RADICALS WITH SILANES. Strausz, O. P.; Jakubowski, E.; Sandhu, H. S.; Gunning, H. E. (Univ. of Alberta, Edmonton). J. Chem. Phys., 51: 552-60(July 15, 1969).

Arrhenius rate parameters for the abstraction reactions of methyl radicals, produced by the photolysis of azomethane, with SiH_4, SiD_4, Si_2H_6, Si_2D_6, and ϕSiD_3 were determined in competition with recombination. Silanes are more reactive than their hydrocarbon counterparts, and the increased reactivity is due to lower activation energies, the A factors being similar. The experimental values of E_a were compared to those calculated by the bond-energy-bond-order method using a simple three-mass-point model. Calculated kinetic isotope effects, based on absolute reaction rate theory, were compared with experimental results. (auth)

40635 FRANCK–CONDON FACTORS FOR THE IONIZATION OF H_2O AND D_2O. Botter, R. (CEN, Saclay, France); Rosenstock, H. M. J. Res. Nat. Bur. Stand., 73A: 313-19(May-June 1969).

Franck–Condon factors were calculated for vertical transitions of H_2O and D_2O involving both bond length and angle changes. It is shown that even in the harmonic oscillator approximation different Franck–Condon factors are obtained for positive and negative angle changes. The results are used to obtain the geometry of the ion ground state. Satisfactory agreement is obtained for the isotope effect on the vibrational transition probabilities. The effects of anharmonicity are discussed semiquantitatively. (auth)

40636 DEUTERIUM ISOTOPE EFFECT ON THE DISSOCIATION OF WEAK ACIDS IN WATER AND DEUTERIUM OXIDE. Robinson, R. A.; Paabo, Maya; Bates, Roger G. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 73A: 299-308(May-June 1969).

The dissociation constants of o-nitroanilinium ion, m-nitroanilinium ion, and 4-chloro-2,6-dinitrophenol in deuterium oxide at 25°C were determined by a spectrophotometric method, and an EMF method was used to obtain $(pK_1 + pK_2)/2$ for citric acid in deuterium oxide. In addition, data for the dissociation constants of other weak acids in ordinary and heavy water were critically examined with a view to clarifying the relationship between the deuterium isotope effect and the intrinsic strength of the acid. The difference ΔpK between the pK value in deuterium oxide and that in water varies linearly with pK above pK = 7. Two stronger inorganic acids (sulfuric and phosphoric) also appear to lie on an extension of this same line. On the contrary, a considerable group of organic acids with pK less than 7 have values of ΔpK that are more or less constant near ΔpK = 0.55. It appears, therefore, that the isotope effect is more complex than has heretofore been assumed. (auth)

40637 HEAT OF COMBUSTION OF BERYLLIUM IN FLUORINE. Churney, K. L.; Armstrong, G. T. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 73A: 281-97(May-June 1969).

An experimental determination of the energies of combustion in fluorine of polytetrafluoroethylene film and powder and of mixtures of beryllium with polytetrafluoroethylene gives reaction (1) $\Delta H^0_{25°C} = -1022.22$ kJ mol^{-1} (-244.32 kcal mol^{-1}) with an overall precision of 0.96 kJ mol^{-1} (0.23 kcal mol^{-1}) at the 95% confidence limits. The total uncertainty is estimated not to exceed ±3.2 kJ mol^{-1} (±0.8 kcal mol^{-1}). The measurements on polytetrafluoroethylene give for reaction (2a) and reaction (2b) $\Delta H^0_{25°C} = -10369.7$ and -10392.4 Jg^{-1}, respectively. Overall precisions expressed at the 95% confidence limits are 3.3 and 6.0 Jg^{-1}, respectively. $Be(c) + F_2(g) = BeF_2$(amorphous) (1), C_2F_4(polymer powder) $+ 2F_2(g) = 2CF_4(g)$ (2a), and C_2F_4(polymer film) $+ 2F_2(g) = 2CF_4(g)$ 2(b). Be_2C and Be metal were observed in a small carbonaceous residue from the combustion of the beryllium–polytetrafluoroethylene mixtures. Methods of analysis for these substances were developed. Gases resulting from the solution of the solid residues in aqueous KOH were analyzed for H_2 and CH_4 by differential absorption in molecular sieves at low temperatures. (auth)

40638 STUDY OF MOLECULAR MOTION IN LIQUID MEDIUM BY MEANS OF THE WIDTH OF INFRARED VIBRATION BANDS. I. BENT TRIATOMIC MOLECULES. SO_2, H_2O, D_2O. Jacob, Janine; Leclerc, Jacques; Vincent-Geisse, Josette (Faculte des Sciences, Paris). J. Chim. Phys., 66: 970-7(May 1969). (In French).

Examination of the profile and width of the vibration bands of substances in a condensed medium gave information concerning molecular motions, especially with regard to the reorientation and the translation inside the liquid. Measurements performed on the three vibration bands of the SO_2 molecule and the two vibrations ν_1 and ν_3 of H_2O and D_2O dissolved in different solvents are described. It was concluded that the SO_2 molecule reorients more easily around the axis of the smallest moment of inertia. The results were much less clearcut for H_2O and D_2O because of the existence, in some cases, of a free rotation. (auth)

40639 ABSENCE OF ABNORMAL ^{14}C ISOTOPE EFFECT IN THE ALKALINE DEGRADATION OF NN-DIMETHYL-o-TOLUIDINE[^{14}C]METHIODIDE. McKenna, J.; McKenna, J. M.; Stuart, J. M. (Univ. of Sheffield, Eng.). J. Chem. Soc., B, No. 6, 698-9(1969).

Degradation of N,N-dimethyl-o-toluidine [^{14}C]methiodide with 5N aqueous potassium hydroxide at 120° exhibited a ^{14}C isotope effect in the usual range ($1 < k^{12}/k^{14} < 1.15$). (auth) (UK)

40640 ISOTOPE EFFECTS ON ACID-BASE EQUILIBRIA OF PYRIDINE AND [$^2H_5$]PYRIDINE IN PROTIUM AND IN DEUTERIUM OXIDE. Bellobono, I. R.; Beltrame, P. (Univ., Milan). J. Chem. Soc., B, No. 6, 620-3(1969).

Equilibrium constants for the dissociation of $C_5H_5NH^+$ and $C_5D_5NH^+$ in H_2O, as well as of $C_5H_5ND^+$ and $C_5D_5ND^+$ in D_2O were measured in the range 5 to 65°C, by spectrophotometric determination of acid–base concentration ratios. Thermodynamic functions ($\Delta G°$, $\Delta H°$, $\Delta S°$) were calculated for these equilibria, and for exchange reactions between deuteriated and non-deuteriated acid and base, in H_2O and D_2O. Primary, solvent, and secondary isotope effects were evaluated as a function of temperature. (auth) (UK)

40641 SIMULTANEOUS ELECTROLYTIC DEPOSITION OF BOTH COMPONENTS AS A NEW METHOD OF INVESTIGATION OF HOMOGENEOUS ISOTOPE EXCHANGE. Gosman, A. (Technical Univ., Prague). Radiochem. Radioanal. Lett., 1: 345-9(Aug. 25, 1969).

A method for investigation of homogeneous isotope exchange, not based on analytical separation of components, is described. (auth)

40642 SUBSTRATE AND SOLVENT HYDROGEN ISOTOPE EFFECTS IN THE PYRIDINE- AND 2,6-LUTIDINE-CATALYSED IODINATION OF DIETHYL KETONE (PENTAN-3-ONE). Calmon, J. P.; Calmon, M.; Gold, V. (King's Coll., London). J. Chem. Soc., B, No. 6, 659-63(1969).

The relative rates of base-catalysed iodination of pentan-3-one and [2,2,4,4-$^2H_4$]pentan-3-one were found to be 4.0: 1 for pyridine catalysis and 6.8: 1 for 2,6-lutidine catalysis in ordinary water at 25°C. The exaltation of the isotope effect for the sterically hindered base parallels previous observations of hydrogen isotope effects with nitroalkanes and shows that it is confined neither to one class of substrates nor to proton transfers between bases of similar strength. The reactions proceed ca. 20% more slowly in D_2O as solvent than in ordinary water. There are indications that this solvent isotope effect is slightly dependent on the isotopic nature of the proton (deuteron) transferred in the process. The solvent isotope effect is substantially independent of the nature of the catalyst base. It is suggested that this argues against the importance of non-equilibrium solvation of the transition state as a cause of the observed variation in the primary isotope effects. (auth) (UK)

40643 KINETICS OF THE ^{36}Cl EXCHANGE REACTIONS BETWEEN GALLIUM(III), ANTIMONY(III), AND ANTIMONY(V) CHLORIDE AND ETHYL CHLORIDE. DeHaan, Franklin P.; Gibby, Michael G.; Aebersold, Dennis R. (Occidental Coll., Los Angeles). J. Amer. Chem. Soc., 91: 4860-3(Aug. 13, 1969).

Kinetic studies were made of the ^{36}Cl exchange reactions between radioactive gallium chloride and ethyl chloride and between radioactive antimony pentachloride and ethyl chloride in excess ethyl chloride. The first reaction is second order in gallium chloride; the second is first order in antimony pentachloride. Enthalpies and entropies of activation were determined for each reaction. Chlorine exchange between radioactive antimony trichloride and ethyl chloride was too slow to permit a rate law determination. At 0°C the relative rates of exchange are: $GaCl_3$, 170; $SbCl_5$, 1; $SbCl_3$, <1/1000. Reaction mechanisms are proposed for the gallium chloride and antimony pentachloride reactions. (auth)

40644 SOLVOLYSIS RATES AND DEUTERIUM ISOTOPE EFFECTS IN 2,2,2-TRIFLUOROETHANOL–WATER MIXTURES. Shiner, V. J. Jr.; Dowd, W.; Fisher, R. D.; Hartshorn, S. R.; Kessick, M. A.; Milakofsky, L.; Rapp, M. W. (Indiana Univ., Bloomington). J. Amer. Chem. Soc., 91: 4838-43(Aug. 13, 1969).

2,2,2-Trifluoroethanol (TFE)–water is a convenient solvent for the precise conductometric measurement of solvolysis rates. A comparison of results in TFE–water with those in ethanol–water gives a useful indication of the role of changing nucleophilicity in solvolysis reactions. It was found that the α- and β-deuterium effects in 1-phenylethyl chloride, which in ethanol–water are at or near a maximum characteristic of a limiting reaction, are not much changed in TFE–water. However, for t-butyl-d_9 chloride the isotope effects are larger in TFE solutions than in ethanol–water. This is explained on the basis of the incursion of some rate-determining elimination from an ion pair in the TFE solvents. p-Methylbenzyl-α-d_2 chloride, and isopropyl-α-d (and -β-d_6) p-bromobenzenesulfonates also show larger effects in TFE–water solvents than in ethanol–water. These results are interpreted in terms of some nucleophilic attack of solvent molecules occurring in the rate-determining steps in the ethanol–water solvents. (auth)

40645 KINETICS OF METAL ION AND METAL CHELATE CATALYZED OXIDATION OF ASCORBIC ACID. IV. URANYL ION CATALYZED OXIDATION. Khan, M. M. Taqui; Martell, A. E. (Illinois Inst. of Tech., Chicago. Texas A and M Univ., College Station). J. Amer. Chem. Soc., 91: 4668-72(Aug. 13, 1969).

The kinetics of the uranyl ion catalyzed oxidation of ascorbic acid at 25 and 40°C is reported. The dissociation constants of ascorbic acid at 40°C, and at an ionic strength of 0.10 M (KNO_3), were obtained from potentiometric titration data and are 2.69×10^{-4} and 1.05×10^{-12}. The dissociation constants of ascorbic acid in D_2O at 25°C and at an ionic strength of 0.10 M (KNO_3) are 2.7×10^{-5} and 6.00×10^{-13}. The uranyl ion catalyzed oxidation of ascorbic acid proceeds by a path first order with respect to substrate, catalyst, molecular oxygen, and hydrogen or deuterium ion concentrations, in accordance with the rate law, $k[H_2A][UO_2^{2+}] \cdot [H^+][O_2]$. The uranyl ion is less active as a catalyst than is the vanadyl ion. The deuterium isotope effect, k_H/k_D, for the uranyl ion catalyzed reaction was found to have the low value of 1.24. Activation parameters for the uranyl ion catalyzed oxidation are reported and compared with those of vanadyl ion catalyzed and uncatalyzed oxidations of ascorbic acid. A probable mechanism is proposed for the uranyl ion catalyzed reaction. (auth)

40646 PROTON AND DEUTERON RELAXATION IN AQUEOUS SOLUTIONS OF VANADYL(IV). EFFECTS OF ELECTRON SPIN RELAXATION AND CHEMICAL EXCHANGE. Reuben, Jacques; Fiat, Daniel (Weizmann Inst. of Science, Rehovoth, Israel). J. Amer. Chem. Soc., 91: 4652-6(Aug. 13, 1969).

Proton and deuteron relaxation times in aqueous solutions of vanadyl(IV) sulfate were studied as a function of temperature. The "excess" nuclear relaxation in this system is governed by both the relaxation time of a nucleus in the first hydration shell, T_{2M}, and its mean residence time, τ_M. These quantities were separated by comparing the proton and deuteron transverse relaxation times in the same solution, taking advantage of the fact that $T_{2M}^H/T_{2M}^D = (\gamma_D/\gamma_H)^2$. The temperature dependence of T_{2M}, governed by the variation of the electron relaxation rate, were thus obtained. The observed behavior closely follows that predicted by the Kivelson theory of electron spin relaxation. It is, thus, demonstrated that reliable results for the electron relaxation and its temperature dependence may be obtained from nuclear relaxation studies. This approach also yielded more accurate values for the kinetic parameters of the acid-catalyzed hydrogen ion exchange between the vanadyl(IV) aquo complex and the uncoordinated water molecules. A deuterium isotope effect on the rate constants was observed, and its relation to the reaction mechanism is discussed. (auth)

40647 STUDY OF PROTACTINIUM PEROXIDE. Muxart, R.; Stchouzkoy, T. (Institut de Physique Nucleaire, Arcueil, France). Radiochem. Radioanal. Lett., 1: 335-40(Aug. 25, 1969). (In French).

Protactinium peroxide was studied by thermogravimetric analysis, differential thermal analysis and infrared spectroscopy. The preliminary results are in better agreement with a hydrated peroxide formulation than with that corresponding to an addition compound. (auth)

40648 THREE TERNARY OXIDES OF Re(VII): $Tl_2Re_2O_{11}$, $Nb_4Re_2O_{17}$, AND $NbReO_6$. Lee, Marie-Renee; Freundlich, William (Laboratoire de Chimie Minerale, Paris). Compt. Rend., Ser. C, 268: 2302-3(June 30, 1969). (In French).

The reaction of Re_2O_7 in the vapor state with TiO_2 and Nb_2O_5 leads to the formation of ternary phases of the composition $Ti_2Re_2O_{11}$, $Nb_4Re_2O_{17}$, and $NbReO_6$. Their crystalline forms were identified, and their stability was studied. (tr-auth)

40649 PROTON RESONANCE INVESTIGATIONS ON PARAMAGNETIC METALLORGANIC URANIUM(IV) ALKOXY COMPOUNDS. Ammon, R. v. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Kanellakopulos, B.; Fischer, R. D. Radiochim. Acta, 11: 162-8(June 1969). (In German).

A number of different paramagnetic tricyclopentadienyluranium-(IV)-alkoxy-complexes were synthesized in rather high yields by a new method, and characterized by various physical properties. Particular attention was paid to the investigation and discussion of the PMR-spectra. It appears possible to estimate the amount of the pseudocontact- and Fermi-contact-contributions to the overall isotropic shift of ring- and alkyl-protons, respectively. The PMR-spectra thus provide excellent supplementary information in addition to previous results obtained from other physical methods about this class of compounds. (auth)

40650 EFFECT OF POLYMORPHISM AND MAGNESIUM SUBSTITUTION ON OXYGEN ISOTOPE FRACTIONATION BETWEEN CALCIUM CARBONATE AND WATER. Tarutani, Toshikazu; Clayton, Robert N.; Mayeda, Toshiko K. (Univ. of Chicago). Geochim. Cosmochim. Acta, 33: 987-96(Aug. 1969).

Calcite, aragonite, and magnesian calcite were slowly precipitated from aqueous bicarbonate solutions, and oxygen isotope fractionation factors between the precipitate and water were measured. For calcite–water at 25 and 0°C, $1000 \ln \alpha = 28.1$ and 33.7, respectively, both values in excellent agreement with the Urey-Epstein paleotemperature scale. Aragonite–water at 25°C gave 28.7, implying a small but significant fractionation between aragonite and calcite. ^{18}O also concentrated in magnesian calcite, relative to pure calcite precipitated under the same conditions, by 0.06 ‰ for each mole percent $MgCO_3$ in calcite. (auth) (UK)

40651 THE INFLUENCE OF HYDROGEN, OXYGEN, AND SULFUR ON NITROGEN ISOTOPE EXCHANGE ON IRON. Schulz, G.; Schaeffer, H. (Max-Planck-Gesellschaft, Berlin). Z. Phys. Chem. (Frankfurt), 64: 333-44(Apr. 1969). (In German).

The activity, the activation energy, and the pressure dependence of nitrogen isotope exchange on iron were measured at pressures between 2 and 20 Torr and at temperatures between 300 and 400°C. Pure as well as poisoned contacts were investigated. The activation energy in oxygen-poisoned contacts was about 10 kcal/mole higher than in the well-reduced contacts. The influence of hydrogen on the exchange rate was studied. On well-reduced contacts an acceleration of the exchange was observed in the presence of hydrogen. (tr-auth)

40652 VISCOSITIES OF PROTONATED AND DEUTERATED WATER SOLUTIONS OF ALKALI METAL CHLORIDES. Ostroff, A. G.; Snowden, B. S. Jr.; Woessner, D. E. (Mobil Research and Development Corp., Dallas). J. Phys. Chem., 73: 2784-5(Aug. 1969).

The effects of various ionic species on the structure of the solution were studied by comparing the viscosities of D_2O and H_2O electrolyte solutions. Relative viscosities were determined for protonated and deuterated water solutions of LiCl, NaCl, KCl, RbCl, and CsCl at 25°C and found to decrease with increasing cation radius. The decrease was greater in D_2O than in H_2O solutions. (J.G.B.)

40653 KINETIC ISOTOPE EFFECTS IN NONEQUILIBRIUM THERMAL UNIMOLECULAR SYSTEMS. ETHYL ISOCYANIDE-d_5. Maloney, Kenneth M.; Pavlou, S. P.; Rabinovitch, B. S. (Univ. of Washington, Seattle). J. Phys. Chem., 73: 2756-60 (Aug. 1969).

The thermal isomerization of C_2D_5NC was studied at 230.9° over a range of pressures from 10^{-3} to 10^2 mm. The fall-off corresponds to an enhanced value of the effective number of oscillators relative to C_2H_5NC. The difference in the observed high-pressure activation energy of the two species is very small [$(E_{aD} - E_{aH})_\infty = 0.15$ kcal mol^{-1}] or zero. The data were treated on an RRKM quantum statistical basis. Calculations were made for several vibration-rotation models. The calculations are in good agreement with experiment. Ethyl isocyanide provided another reaction system for which the large inverse intermolecular secondary isotope effect predicted earlier was found; k_H/k_D declined from 1.10 at $p = \infty$ to 0.21 at $p \approx 10^{-3}$ mm; the agreement between theory and experiment supports a value of around 0.2 at $p = 0$. (auth)

40654 NITROGEN ISOTOPE EFFECT IN TRANSITION METAL HEXAAMMINE COMPLEX–AMMONIA SYSTEMS. A THEORETICAL CONSIDERATION. Jeevanandam, M.; Gupta, A. R. (Bhabha Atomic Research Centre, Trombay, India). J. Phys. Chem., 73: 2472-7(Aug. 1969).

The nitrogen isotope effects in $Co(NH_3)_6^{3+}$–, $Co(NH_3)_6^{2+}$–, Cr $(NH_3)_6^{3+}$–, $Ni(NH_3)_6^{2+}$–, and $Rh(NH_3)_6^{3+}$–NH_3 exchange systems were calculated taking into consideration all the vibrational degrees of freedom of the complex ions. The vibrational frequencies of ^{15}N substituted complexes were computed using the modified Urey–Bradley force-field constants derived on the basis of the normal coordinate analysis of the fundamentals. The nitrogen isotope effects in $Co(ND_3)_6^{3+}$– and $Ni(ND_3)_6^{2+}$–ND_3 systems were also calculated. The results show that in such complicated systems, isotope effects cannot be correlated with any one particular force constant related to the internal coordinate of the isotopically substituted atom. There seems to be a direct relationship between the nitrogen isotope effects in these systems and the stability constant of the complexes involved. (auth)

40655 ON THE INTERMEDIATE SOLVENTS IN DECALIN LIQUID SCINTILLATORS. Koike, Yuji; Yamamoto, Kakuji (Tokyo Metropolitan Isotope Research Center). Oyo Butsuri, 38: 668-73(July 1969). (In Japanese).

Relations between pulse height and concentration of intermediate solvents in decalin liquid scintillators have been studied. The intertermediate solvents used were naphthalene and its derivatives. The pulse height at room temperature was found to increase with concentration of intermediate solvents over the range 0.005 ~ 0.1 M. But the pulse height at −6°C increased markably with higher concentration of intermediate solvents. Such variations of pulse height may be understood from an analysis of the fluorescence spectrum of excimer of intermediate solvents. The excimer, in general, acts as a quencher. By proper selection of solvents, intermediate solvents, and solutes, intermediate solvents act as a sensitizer in the liquid scintillators. The contribution of the excimer of intermediate solvents are discussed. (NSA of Japan)

40656 POSSIBILITY OF USE OF CHELATING AGENTS IN PRIMARY CIRCUIT OF WATER-COOLED NUCLEAR REACTOR WITH TWO CIRCUITS. Konochkin, V. G.; Slyusarev, P. N.; Kayurov, B. M.; Stuzhnev, Yu. A.; Margulova, T. Kh.; Lenskii, A. R.; Bogatyreva, S. V.; Bursuk, L. M. At. Energ. (USSR), 27: 96-101(Aug. 1969). (In Russian).

A study was made to determine the feasibility of using chelating agents in the primary circuit of nuclear power stations to correct water conditions. Results are given for ferrous–EDTA chelates, which increase the corrosion stability of carbon steels. The work was carried out on a reactor loop partially constructed of carbon steel. The addition of chelating agent was studied both in the absence of power and at full reactor power. Subsequent exploitation of the processed loop and tube pieces proved a protective film was formed. (auth)

40657 THE ISOTOPE EFFECT OF HYDROGEN ON THE AUTOXIDATION OF BENZENE AND TOLUENE IN AQUEOUS SOLUTIONS. Hotta, Hiroshi; Suzuki, Nobutake; Komori, Takuji (Japan Atomic Energy Research Inst., Takasaki). Bull. Chem. Soc. Jap., 42: 2041-2(July 1969).

Studies were made on the autoxidation of an equimolar mixture of C_6H_6 and C_6D_6 and one of $C_6H_5CH_3$ and $C_6D_5CD_3$, which was initiated by Fenton's reagent. The isotope effect of hydrogen or the rate constant ratio of this reaction, k_H/k_D, was then estimated from the isotopic composition of the products at a low reaction conversion by using the equation $(k_H/k_D) = [(RD)/(RH)] \times [(Product)/(d\text{-}Product)]$ where (RD)/(RH) is the initial mole ratio of the deuterated reactant to the normal reactant, which was unity, while (Product)/(d-Product) is the mole ratio of the normal product to the deuterated product. The values (4.5 to 4.8) obtained for toluene were similar to the values for the propagation process of the autoxidation of aromatic hydrocarbons. The value obtained for benzene at 70°C (2.4) appeared to be unexpectedly high. It is speculated that the process at 70°C includes a different reaction route, which has a higher isotope effect from that at 20°C. (P.C.H.)

40658 EFFECT OF IMPURITIES ON THE WHITENESS OF LANTHANUM OXIDE. Miyazaki, Kazuhide (Mitsui Mining and Smelting Co., Tokyo). Bull. Chem. Soc. Jap., 42: 2046-8(July 1969).

The detrimental effects of three common impurities, Pr, Nd, and Ca, on the coloring of La_2O_3 were investigated in terms of the Munsell value scale, using a color difference meter. The coexistence of Pr and Ca was most distinct in degrading the white color of La_2O_3, while Nd was a minor coloring source even when combined with Ca. The effects of Pr present in a minor amount were not very pronounced without the simultaneous presence of

Ca. The combination of Pr and Nd did the most harm in the presence of Ca. (auth)

40659 THE CHEMISTRY OF PROTACTINIUM. VII. THE STABILITY OF PROTACTINIUM(V) IN PERCHLORIC ACID AND TTA-BENZENE SOLUTIONS. Suzuki, Shin; Inoue, Yasushi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 42: 1916-21(July 1969).

In an attempt to understand the reasons for the confusion in published works as to the chemical behavior of protactinium(V) in a perchloric acid solution, the effects of the contact time and the stability of the perchloric acid solution of the pentavalent protactinium in the TTA–benzene extraction have been investigated in relation to the methods for preparing the solution. Four sample solutions, prepared by various methods, were used, and definite differences among them were observed. Two of them have been confirmed to be very stable and not to suffer a change in their distribution ratios with the time of standing, while the others are unstable–that is, their distribution ratios decrease with standing, thereby reaching a constant value which agrees with that of the former two. However, the value consistent with that obtained from backward extraction was not this constant value but the value obtained from fresh solutions of the latter type. Protactinium species in the TTA–benzene solution also were not stable, and their distribution ratios increased with standing. This increase in the distribution ratio was mainly due to the formation of unstrippable species. The mechanism of this irreversible change was assumed, from the indirect evidence of extraction experiments and absorption spectroscopy, to be the irreversible dehydration of $Pa(OH)_2T_3 \cdot HT$ to form $PaOT_3 \cdot HT$ in the organic phase. These unfavorable features of the extraction equilibrium should be taken into account in interpreting the results obtained by TTA extraction experiments. (auth)

40660 THE STRUCTURE THEORY OF WATER. II. THE THERMODYNAMIC PROPERTIES OF LIQUID DEUTERIUM OXIDE. Arakawa, Kiyoshi; Sasaki, Katsutaka; Endo, Yuko (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap., 42: 2079-81(July 1969).

A statistical thermodynamic theory based on a two state model, which consists of an ice-like structure (class I) and unbonded monomers (class II), was applied to liquid D_2O, with the intention of explaining the thermodynamic properties of the liquid and to test the applicability of the two state model. The results support the idea that the bond strength of O—D. . .O is stronger than that of O—H. . .O. It was concluded that the two state theory for liquid water gives an adequate representation of the thermodynamic behavior of liquid behavior of liquid D_2O. (P.C.H.)

40661 THE KINETIC STUDY OF THE PHOTOSENSITIZED ELECTRON EXCHANGE REACTION BETWEEN URANIUM(IV) AND URANIUM(VI) IN HYDROCHLORIC ACID. Kato, Yasuyoshi; Fukutomi, Hiroshi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 1-7(Mar. 1969).

The electron exchange reactions of U(IV)-U(VI) under illumination of a Hg lamp were studied. The rate of reaction was found to be accelerated by ~600 times by uv irradiation, and the rate equation had a fractional order with respect to U(IV) and U(VI). The activation energy decreased to ~60% of the value determined in darkness. (NSA of Japan)

40662 HYDROGEN EXCHANGE REACTION OF AMINOBENZOIC ACID. I. COMPARISON BETWEEN WILZBACH TRITIATION AND ACID-CATALYZED HYDROGEN EXCHANGE REACTION. Matsuo, Mitsuyoshi; Matsuo, Toshiyasu; Kasida, Yosihiko; Kondo, Tatsuo (National Inst. of Radiological Sciences, Chiba, Japan). Chem. Pharm. Bull. (Tokyo), 17: 495-8(Mar. 1969).

The mechanism of Wilzbach tritiation was studied by comparing the ^3H labeling of ortho-, meta-, and para-aminobenzoic acids with acid-catalyzed hydrogen exchange reaction and bromination. The acid-catalyzed hydrogen exchange reaction of the acids in 4N DCl occurred at ortho and para to the amino group of the acids, and it was confirmed that the reaction was a typical electrophilic substitution. Tritium incorporation in the acids by Wilzbach labeling was high at ortho and para to the amino group of the acids, although the order of reactivity on Wilzbach labeling did not completely agree with that in the acid hydrogen exchange reaction. This suggests that HeT^+ ion participates predominantly in the labeling. (BBB)

40663 EXCHANGE REACTIONS OF OXIDES. PART X. THE RARE-EARTH SESQUIOXIDES. Winter, E. R. S. (John and E. Sturge Ltd., Birmingham, Eng.). J. Chem. Soc., A, No. 12, 1832-5(1969).

The kinetics of oxygen-18 exchange between enriched oxygen gas and the stable rare earth sesquioxides and terbium oxide were examined. Most of the oxides exchange by a dissociative mechanism confined to the surface layer of oxygen ions. As for other metallic oxides there is a strong compensation effect between A_0 and E in the rate expression and there is a correlation between the size of the unit cell and related crystal parameters and E. There is no correlation between magnetic properties of the M^{3+} ion and the exchange kinetics. (auth) (UK)

40664 NUCLEAR MAGNETIC RESONANCE DATA ON DEUTERATED POLYSTYRENES. Segre, Anna Laura; Ferruti, Paolo; Toja, Emilio; Danusso, Ferdinando (Politecnico, Milan). Macromolecules, 2: 35-6(Jan.-Feb. 1969).

The ^2H-decoupled NMR spectrum of isotactic $[-C_6D_5CHCD_2-]_x$ shows a singlet having a width of 1.1 cps, centered at 218.8, and 2 small peaks at 216.4 and 223.0 cps, whose intensity is the same as that of another multiplet at 145 cps, the latter being clearly due to the residual β,β protons (as isotopic impurities). The ^2H-decoupled spectrum of a d_7 radical polystyrene sample prepared at 18°C shows a larger number of peaks than previously described for a radical polystyrene-β,β-d_2. At least 6 peaks are apparent in the spectrum, and these are broad and poorly resolved. The spectrum is compared with that of a d copolymer prepared by radical polymerization at 18°C of a mixture of d_7 (20%) and d_8 (80%) monomers. In the latter, the number of resolved peaks is still 6 at 193, 195, 199, 206, 216, and 226 cps from HMDS. By increasing the polymerization temperature of radical d_7, d_8 copolymers, to 60 and 100°C, only a slight increase of the 216-cps peak and a loss of resolution in the 195- and 193-cps bands were observed. Spectra of the isotactic d_7-polymer and the free-radical d_7 polymer and d_7-d_8 copolymer are illustrated. (BBB)

40665 INVESTIGATION OF ISOTOPE EXCHANGE BETWEEN THE SURFACE OF CRYSTALS OF $Na_2SiO_3.9H_2O$ AND A SOLUTION OF SODIUM METASILICATE. I. Babayan, S. G.; Arutyunyan, A. M.; Manvelyan, M. G. (Erevan Scientific Research Inst. of Chemistry). Arm. Khim. Zh., 21: 81-8(1968). (In Armenian).

Kinetics of exchange are discussed, and the special apparatus designed for the experiments illustrated and described. The production of $Na_2SiO_3 \cdot 9H_2O$ crystals with stable surfaces, and means for monitoring surface stability, are outlined; application of these techniques to radiochemical studies is treated. Studies of the kinetics of isotope exchange are principally determination of the extent of exchange with time, and extraction of the rate constant for isotopic exchange of ^{22}Na. The ratio of rate constants for deposition and solution of ^{22}Na is 0.331. The result is discussed in terms of the crystalline structure of the nonahydrate. Rate constants obtained are: $K_{deposition}$, 0.163 ± 0.004; $K_{solution}$, 0.053 ± 0.004. (BBB)

40666 HYDROGEN–TRITIUM EXCHANGE OF THE RANDOM CHAIN POLYPEPTIDE. Englander, S. W.; Poulsen, A. (Univ. of Pennsylvania, Philadelphia). Biopolymers, 7: 379-93(Mar. 1969).

The hydrogen–tritium exchange character of poly-D,L-alanine (PDLA) and poly-D,L-lysine (PDLL) was studied in detail as a model for the H–T exchange behavior of the unhindered, polymeric peptide group. Sephadex columns were used to separate tritiated polymer from free tritium, and the decrease, in time, of bound tritium (exchange-out) kinetics was measured by assaying, in Sephadex column eluant, for polymer concentration and residual, bound tritium. The random chain nature of PDLA was evident in the uniformity of exchange rate of all its hydrogens and in the similarity between this rate and that of random chain PDLL and other known, unhindered secondary amide groups. An equilibrium isotope effect favoring the binding of tritium over protium to the extent of 21% was measured. Specific acid and base catalysis of the exchange and the absence of detectable general catalysis were demonstrated. Apparent energy of activation is 17 kcal/mole for deprotonation, largely due to dependence of k_w on temperature, and 15 kcal/mole for protonation, which correlates with the extreme apparent pK. The H–T exchange half-time rate of PDLA at any pH and temperature (T;°C) is given by the equation: $t_{½}$ (min) = $200 \times 10^{0.05T}/[10^{pH-3} + 10^{3-pH}]$. (BBB)

40667 ESR OF Ni^{2+} IN AgCl AND ISOTOPE EFFECT IN CRYSTAL FIELD. Hoehne, M.; Stasiw, M.; Watterich, A. (Zentralinstitut fuer Elektronenphysik, Berlin). Phys. Status Solidi, 34: 319-27(July 1, 1969).

ESR measurements are made on Ni-doped AgCl at low temperatures. As in the case of AgBr : Ni a line with isotropic g-value is found, due to isolated Ni^{2+}. Moreover an angular dependent spectrum with nearly [100]-axial symmetry is observed, which is attributed to complexes of Ni^{2+} with a silver vacancy. Contrary to the results on AgBr : Ni a structure of the anisotropic spectrum is observed in a small angular range, which may be explained only by the presence of very small orthorhombic perturbations.

It is shown that these orthorhombic perturbations of different quantities result from the variant distributions of both the isotopes ^{35}Cl and ^{37}Cl in the plane perpendicular to the axis of the centre. (auth)

40668 INFLUENCE OF ZERO-POINT VIBRATION ON THE SUPERHYPERFINE INTERACTIONS OF HYDROGEN AND DEUTERIUM CENTRES IN KCl. Spaeth, J. M. (Univ., Stuttgart). Phys. Status Solidi, 34: 171-81(July 1, 1969).

The superhyperfine (shf) interactions of D_i^0 centers were measured by ENDOR and compared with those of H_i^0 centers (H_i^0 = H atom on interstitial lattice position). The isotropic shf constants of the nearest K and Cl neighbors are smaller for D_i^0 centers than for H_i^0 centers: $a_H(K)/a_D(K) = 1.165$ and $a_H(Cl)/a_D(Cl) = 1.026$. In a model calculation it is shown that the large difference in isotope effect of the K and Cl neighbors can be understood as a consequence of the overlaps of their ion cores. At least 30% of $a_H(K)$ and 10% of $a_H(Cl)$ are only due to zero-point vibrations of the H atom. (auth)

40669 A TWO COMPONENT X-RAY TECHNIQUE FOR THE PRECISION DETERMINATION OF LATTICE PARAMETERS AND THERMAL EXPANSION OF CeO_2, Ho_2O_3, AND Lu_2O_3 AT LOW TEMPERATURE. Gupta, Murari Lal. Washington, D. C., Howard Univ., 1968. 155p. Thesis.

In order to make the precision determination of the lattice parameters by the back-reflection x-ray methods, a standard is essential. The two component x-ray technique was developed that does not require a standard because the necessity of a standard is eliminated by using the two components of the Kα x radiation. Thermal expansion of the rare earth oxides has been studied above room temperature by others, but no such data are available at low temperatures. Attempts were made to fill this gap for some of the oxides. The back-reflection patterns of cerium dioxide, holmium sesquioxide, and lutetium sesquioxide with the copper Kα x-ray beam are sharp and intense and contain the Kα-doublets. Therefore these oxides were studied using the method described. The principle of the two component x-ray technique consists of using the components of the Kα x-radiation for computing the lattice parameters. In this way a knowledge of the distance between specimen and film or of the camera radius is not needed. Since the $K\alpha_1$ and $K\alpha_2$ diffraction lines are used, the technique is called the two component x-ray technique. Using the Bragg law and the trigonometric relations of these reflection lines for a flat camera, an equation for a cubic crystal was derived: $16\,(R_1^2\lambda_2^2 - R_2^2\lambda_1^2)\,a^6 + 4S[4\lambda_2^2 + \lambda_1^2)\,\lambda_1^2R_2^2 - (\lambda_2^2 + 4\lambda_1^2)\lambda_2^2R_1^2]a^4 + (\lambda_1^2 + \lambda_2^2)(R_1^2 - R_2^2)\;4\lambda_1^2\lambda_2^2S^2a^2 + \lambda_1^4\lambda_2^4\,(R_2^2 - R_1^2)S^3 = 0$, where R_1, R_2 are the radii of the corresponding lines, λ_1 and λ_2 the wavelengths of the $K\alpha_1$ and $K\alpha_2$ x-radiations, S the sum of the square of the reflection indices, and a the lattice parameter of a cubic crystal. This equation is used to compute the lattice parameter values. If the lattice constants of a crystal lattice are known, it is possible to investigate which substance would give the back-reflection Kα-doublets, and this technique could be applicable to those crystals. The applicability of the technique is discussed theoretically for various cubic crystals. In a comparison of the room temperature lattice parameter values of these oxides with other investigations, high precision was found. The thermal expansion results are interpreted in terms of the Gruneisen theory. The compressibility data of these oxides are not available at any temperature; therefore, λ for them cannot be computed. As compressibility and specific volume depend only slightly on temperature, the Gruneisen equation simply states that the ratio of specific heat to thermal expansion coefficient should be approximately constant. This ratio was computed for CeO_2 and Ho_2O_3. The ratio C_p/β could not be calculated for Lu_2O_3 because its specific heat data are not available. The value of $C_p/\beta \times 10^{-6}$ for CeO_2 was between 4.9 and 4.7 with the temperature range from 100 to 300°K. For Ho_2O_3, this ratio varied from 1.26 to 1.24 in the same temperature range; the C_p/β value for both the oxides was approximately constant. Therefore, from the results it could be concluded that these oxides obey Gruneisen model in this temperature range. This was also found true for many oxides, for example Al_2O_3 and MgO. (Diss. Abstr.) (TSS)

40670 THE REDUCTION OF THE BETA DIOXIDE OF URANIUM BY HYDROGEN IN THE PRESENCE OF Nb_2O_5. Pis'menko, V. T.; Vlasov, V. G.; Larin, A. A. (Ural Politechnical Inst., Sverdlovsk, USSR). Zh. Neorg. Khim., 14: 1727-31(July 1969). (In Russian).

The kinetics of the reduction of U_4O_9 by hydrogen in the presence of homophase and heterophase additions of Nb_2O_5 at various temperatures was studied. The activation energy for the reduction of U_4O_9 and U_4O_9 modified by additions of Nb_2O_5 was found to be E = 23 ± 3 kcal. The inhibiting effect of Nb_2O_5 additions is due to the formation of a new chemical compound and the migrations of Nb^{5+} ions into the lattice of U_4O_9. (tr auth)

40671 THE INVESTIGATION OF THE CHROMATOGRAPHIC BEHAVIOR OF THE RARE EARTH ELEMENTS IN AQUEOUS ACETONE SOLUTIONS OF HCl BY THIN-LAYER CHROMATOGRAPHY ON SILICA GEL. Volynets, M. P.; Ermakov, A. N.; Fomina, T. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Neor. Khim., 14: 1806-11(July 1969). (In Russian).

Studies by thin-layer chromatography showed that sorption by silica gel of rare earths, yttrium, and thorium from aqueous acetone solutions of HCl varies, especially in regions of high concentrations of HCl. (tr auth)

40672 INTERACTION OF MOLYBDENUM DIOXYDICHLORIDE WITH CHLORIDE DERIVATIVES OF CERTAIN GROUP IV ELEMENTS. Korshunov, B. G.; Nirsha, B. M. (Moscow Inst. of Thin Chemical Technology). Zh. Neorg. Khim., 14: 1971-2(July 1969). (In Russian).

Differential thermal and visual polythermal methods were used to study interactions in binary systems of MoO_2Cl_2 with $SiCl_4$, $GeCl_4$, $SnCl_4$, $TiCl_4$, $POCl_3$, and $VOCl_3$. Phase diagrams are included. (tr auth)

40673 ISOTOPIC EXCHANGE OF CERTAIN LANTHANIDES IN SYSTEMS WHICH CONTAIN ETHYLENEDIAMINETETRAACETIC AND DIETHYLENETRIAMINEPENTAACETIC ACIDS. Fomin, V. V.; Maiorova, E. P.; Leman, G. A. Zh. Neorg. Khim., 14: 1906-11(July 1969). (In Russian).

Exchanges of europium and yttrium isotopes in systems containing ethylenediaminetetraacetic acid or diethyienetriaminepentaacetic acid and neodymium in systems containing diethylenetriaminepentaacetic acid were studied. Rate constants for isotopic exchange reactions at 12 and 25°C and the energies of activation were calculated. (tr auth)

40674 ROTATIONAL SPECTRA OF SUBSTITUTED DIAZIRINES. III. METHYLCHLORODIAZIRINE. Wollrab, James E. (McDonnell Douglas Corp., St. Louis); Scharpen, LeRoy H. J. Chem. Phys., 51: 1584-90(Aug. 15, 1969).

Ground-state rotational spectra of $CH_3{}^{35}ClCN_2$ and $CH_3{}^{37}ClCN_2$ were assigned, and the derived r_0 structural parameters are: r(NN) = 1.241 ± 0.005 Å, r(CCl) = 1.743 ± 0.01 Å, r(CC) = 1.498 ± 0.01 Å, ∢C−C−Cl = 116.7° ± 1.0°, $∢CCN_2$ = 124.5° ± 1.0°, and ∢NCN = 50.2° ± 0.5°. The internal-rotation splittings for $CH_3{}^{35}ClCN_2$ yield a barrier to internal rotation of 1689 ± 10 cal mole^{-1}. The Cl quadrupole coupling constants (megahertz) for $CH_3{}^{35}ClCN_2$ are $\chi_{aa} = -66.51$, $\chi_{bb} = 32.91$, $\chi_{cc} = 33.60$ and for $CH_3{}^{37}ClCN_2$ are $\chi_{aa} = -53.07$, $\chi_{bb} = 26.40$, $\chi_{cc} = 26.67$. The nitrogen quadrupole splittings were generally unresolved. (auth)

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Refer also to abstracts 40534, 40616, 40630, 40857, 40860, 41107, 41231, 41613, 41754, 42393, 42413, 42422, 42423, 42425, 42459, and 42460.

40675 (ANL-7569) THE PREPARATION OF HIGH-PURITY ^{242}Cm IN MULTICURIE QUANTITIES. Horwitz, E. P.; Bloomquist, C. A. A.; Griffin, H. E. (Argonne National Lab., Ill.). May 1969. Contract W-31-109-eng-38. 12p. Dep. CFSTI.

^{242}Cm was prepared in 20- to 30-Ci quantities by neutron irradiation of 150 to 230 mg of $^{241}AmO_2$ encapsulated in aluminum. The irradiated capsule was dissolved in concentrated HNO_3 containing a Hg^{2+} catalyst. A high-molecular-weight, quaternary ammonium nitrate extractant (Aliquat-336 nitrate) in xylene was used to extract the curium and americium from the resultant $Al(NO_3)_3$ solution and also from certain fission products. The bulk of the ^{241}Am was removed from the ^{242}Cm by oxidation of the Am(III) to Am(V) in 4$\underline{M}$ K_2CO_3. Additional decontamination of ^{241}Am from ^{242}Cm was achieved by extraction chromatography using Aliquat-336 nitrate on Celite and a $LiNO_3$ elutriant. Lanthanide fission products remain in the americium fraction. Final purification of the ^{242}Cm was carried out by extraction chromatography using DEHPA on Celite and a dilute nitric acid elutriant. The final product was spectroscopically pure (>99.9%) of such impurities as Na, Ca, Al, and Fe, and radiochemically pure of all fission products. The ^{241}Am was reduced to ~100 ppM by mass, corresponding to an alpha-activity ratio of $10^7 : 1$ (^{242}Cm : ^{241}Am). (auth)

40676 (BNL-50149, pp 40-75) RADIATION DIVISION. Manowitz, B. (Brookhaven National Lab., Upton, N. Y.).

AIR—radiolysis of, bubbling through water, yields of ammonia, nitrate ions, and nitrite ions from γ

AMIDES—reactions of irradiated, with nitric oxide, oxygen, and sulfur dioxide, diffusion studies on

AMMONIA—radiolysis of, yields of azides in

ARGON—radiolysis at 100 to 1000 torr, electron recombination following pulse
BENZOYL PEROXIDE—effects of γ-radioinduced polymerization of styrene at 20°C
CARBON DIOXIDES—radioinduced decomposition of, effects of catalysts on γ
CARBON MONOXIDES—yields from radiolysis of substituted nitrophenols, isomeric effects on
CARBON TETRACHLORIDE—effects of electron scavengers of, on nitrogen and oxygen yields from α- and γ-radiolysis of nitrous oxide
CELLOPHANE—properties of membranes of
CHEMICAL REACTIONS—stability of photoinitiated chain, calculations for
ELECTRODES—radiation effects on performance of oxygen, β and γ
—radiation effects on potential of saturated calomel, γ
GAMMA RADIATION—effects on polymerization of methyl methacrylate and styrene in concretes
GASES—radiolysis at 100 to 1000 torr, electron recombination following pulse
HYDROGEN—yields from radiolysis of substituted nitrophenols, isomeric effects on
IN-PILE LOOPS—testing of chemonuclear, in Brookhaven Graphite Research Reactor
IRRADIATION FACILITIES—development of β, for extracorporeal exposure of blood
NITROGEN—yields from radiolysis of substituted nitrophenols, isomeric effects on
NITROGEN OXIDES NO—yields from radiolysis of substituted nitrophenols, isomeric effects on
—effects of electron scavengers of, on nitrogen and oxygen yields from α- and γ-radiolysis of nitrous oxide
—yields from γ radiolysis of nitrogen–oxygen systems
—radiolysis of, effects of electron scavengers on nitrogen and oxygen yields from α and γ
OXYGEN—radiolysis at −100°C, effects of nitrogen on ozone yields from
PHENOL, m-NITRO—radiolysis of substituted, isomeric effects on yields from
PHENOL, o-NITRO-—radiolysis of substituted, isomeric effects on yields from
PHENOL, p-NITRO-—radiolysis of substituted, isomeric effects on yields from
POLYMERIZATION—radioinduced, effects of mixing on rate of uv
RADIATION DOSIMETERS, PHOTOLUMINESCENT—development of quartz, for γ-dosimetry at 5 to 50 kRad
SCREENS—radiolysis of nitrous oxide on Linde 13X, effects of oxygen and temperature on
STYRENE—polymerization of dry, rate of
—radioinduced polymerization at 20°C, effects of benzoyl peroxide on γ
STYRENE, α-METHYL-—polymerization of dry, rate of
SULFUR FLUORIDES—effects of electron scavengers of, on nitrogen and oxygen yields from α- and γ-radiolysis of nitrous oxide
VESSELS—radioinduced chain reactions in, effects of diffusion and mixing on
—performance of continuous stirred, for radioinduced polymerizations
—performance of continuous tubular radiation chemical reactor, effects of flow regime on
—performance of continuous stirred, for γ-radioinduced chemical reactions (P.C.H.)

40677 (BNL-50149, pp 76-88) HOT LABORATORY DIVISION. Stang, L. G. Jr. (Brookhaven National Lab., Upton, N. Y.).

ACETONE—effects on retention of hafnium and zirconium in fast and thermal neutron irradiation of hafnocene and zirconocene
ALUMINUM—effects on solvent extraction of indium in acetate–citrate system using TTA
ANTIMONY—energy level densities of
BENZENE—effects on retention of hafnium and zirconium in fast and thermal neutron irradiation of hafnocene and zirconocene
1,3-BUTANEDIONE, 4,4,4-TRIFLUORO-1-(2-THIENYL)-—solvent properties for indium in acetate–citrate system, effects of aluminum, cerium, and chromium on
2-BUTANONE—solvent properties for isomeric technetium-99 in irradiated molybdenum oxide
CADMIUM-114—energy level densities of
CALIFORNIUM ISOTOPES—production from epithermal neutron irradiation of californium-252
CERIUM—effects on solvent extraction of indium in acetate–citrate system using TTA
CHROMIUM—effects on solvent extraction of indium in acetate–citrate system using TTA
CITRATES—complexes with indium and uranyl ions, spectrophotometric studies on
HAFNIUM, DICHLORODICYCLOPENTADIENYL-—radiation effects on, effects of solvents on hafnium retention in fast and thermal
HAFNIUM ISOTOPES—retention in fast and thermal neutron irradiation of hafnocene, effects of acetone and benzene on
HOLMIUM-166—energy level densities of
INDIUM—energy level densities of
—separation by solvent extraction using TTA in acetate–citrate system, effects of aluminum, cerium, and chromium on
—complexes with citrates and uranyl ions, spectrophotometric studies on
MAGNESIUM-26—reactions with tritons at 3.4 MeV, production of magnesium-28 by
MAGNESIUM-28—production by triton bombardment of enriched magnesium-26 rod
MOLYBDENUM OXIDES—separation of isomeric technetium-99 from irradiated, using 2-butanone
TECHNETIUM-99—separation of isomeric, from irradiated molybdenum oxide using 2-butanone
TELLURIUM—energy level densities of
TIN—energy level densities of
TRITONS—reactions with magnesium-26 at 3.4 MeV, production of magnesium-28 by
URANYL IONS—complexes with citrates and indium, spectrophotometric studies on
ZIRCONIUM, DICHLORODICYCLOPENTADIENYL-—radiation effects on, effects of solvents on zirconium retention in fast and thermal neutron
ZIRCONIUM ISOTOPES—retention in fast and thermal neutron irradiation of zirconocene, effects of acetone and benzene on (P.C.H.)

40678 (CEA-R-3800) THE γ RADIOLYSIS AT ROOM TEMPERATURE OF LIQUID DEAERATED ISOPROPANOL. Gilles, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1969. 106p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay.

The main products formed in the room-temperature γ radiolysis of liquid isopropanol, and their respective yields, are: hydrogen 3.8, methane 1.6, acetone 3.4, acetaldehyde 1.1, and pinacol 0.3. These results give a material balance in good agreement with the formula of isopropanol and lead to a value for the yield of decomposition: 5.3. The absence of 2,3-butanediol shows that the acetaldehyde cannot come from the dismutation of hydroxyethyl radicals. The variations of the hydrogen yield in the neutral medium with the concentration of added electron scavengers may be explained in terms of the model proposed by Freeman and Fayadh, which supposes the existence of spurs. The yield of solvated electrons diffusing into the bulk of the solution and also the ratios of rate constants for the reactions of the scavengers with the electrons may likewise be obtained on the basis of this model. Certain effects not foreseen by this model may result from the capture of electrons solvated or not, whose mode of disappearance in pure alcohol remains unknown. A yield of excited molecules of at least 2 may be distinguished, of which 80% lead to the production of molecular hydrogen and 20% to that of molecular methane, and an ionization yield of 2.2. The discussion of the various mechanisms that may lead to the formation of the products indicates that these yields may be higher than the values quoted. (auth)

40679 (COO-1054-43) DELAYED LUMINESCENCE IN ALKALI HALIDES UNDER F BLEACHING. Manilerd, C.; Kim, Y. W. (Wayne State Univ., Detroit, Mich. Dept. of Physics). [nd]. Contract AT(11-1)-1054. 13p. Dep. CFSTI.

Samples of NaF, LiF, NaCl, and KCl were x-irradiated (40 keV–20 mA) at 300°K for a few seconds to 20 minutes. The luminescence spectrum of these samples under F bleaching was studied with controlled time delay between bleaching and emission. The delayed luminescence (D.L.) of NaF and LiF gave spectra centered near 580 mμ with half-width close to 60 mμ. For KCl, the spectrum peaked at 420 mμ with half-width of 74 mμ. The corresponding spectrum of NaCl was not successfully resolved. The growth and decay of the D.L. for NaF are characterized by the activation energy: 0.014 ± 0.002 eV and 0.024 ± 0.002 eV. The effects of temperature were also investigated. Comparative analysis of the data appear to favor a model based on the recombination between a vacancy-pair with hole, and the electron released from an F center under F bleaching. (auth)

40680 (COO-1617-18) REACTIONS OF IODINE ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ISOMERIC TRANSITION WITH GASEOUS AND CONDENSED STATE POLYHALOMETHANES. Parks, Norris J. (Nebraska Univ., Lincoln. Dept. of Chemistry). 1969. Contract AT(11-1)-1617. 121p. Dep. CFSTI.

Thesis.

The organic yields of ^{130}I + ^{130m}I activated by radiative neutron capture and those of ^{130}I activated by isomeric transition were found to decrease for the liquid systems studied in the order $CH_2Cl_2 > CHCl_3 > CFCl_3 > CCl_4 \cong CCl_3Br$. The organic yields of (n,γ) activated ^{130m}I + ^{130}I were consistently lower than the (IT)-induced yields of ^{130}I. The products and their relative abundance were determined by radiogas chromatographic analysis. These determinations, together with other considerations, suggest the observed results may be primarily ascribed to variations in product stability, which are related to variations in steric interactions among substituents of product molecules. The reactions of (n,γ)-activated ^{128}I with gaseous CH_3X, CH_2X_2, CHX_3, and CX_4 (X = F and/or Cl) were examined. The comparisons of total organic yields and indications that halogen replacement products are preferentially formed suggest that steric interaction between substituents of both reactant and product molecules is also an important factor controlling the extent of reactions in gaseous systems. The organic yields were found to decrease with increasing halogen substitution for the homologous halomethane series studied. The similar yields of (IT)-induced reactions of ^{130}I and the (n,γ)-induced reactions of ^{128}I in liquid systems, and the finding that additives capable of efficient charge transfer reaction with the activated species in the gas phase effectively inhibit (n,γ)-induced reaction of ^{128}I with the target system are indications that the reactive species are ions possessing excess kinetic and/or electronic energy. (auth)

40681 (N-69-24940) RADIATION INDUCED REDUCTION OF AMMONIACAL NICKEL(II) SULFATE TO METALLIC NICKEL. Philipp, Warren H.; Marsik, Stanley J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1969. 14p. (NASA-TN-D-5213). CFSTI.

Aqueous ammoniacal nickel(II) sulfate containing a variety of soluble organic compounds were irradiated with 2-MeV electrons. When this organic additive was either a primary alcohol, secondary alcohol, or cyclic ether, the divalent nickel was reduced to elemental nickel powder. The reaction mechanism involves the decomposition of water by the ionizing radiation into hydrogen atoms and hydroxyl radicals. The organic additive scavenges the hydroxyl radicals by reducing them, and the remaining hydrogen atoms then reduce the divalent nickel to the free metal powder. (auth)

40682 (NYO-3682-7) THEORETICAL INVESTIGATIONS OF RADIATION EFFECTS IN IONIC CRYSTALS. Final Report, April 15, 1963–April 14, 1969. Bartram, Ralph H. (Connecticut Univ., Storrs. Dept. of Physics). Contracts AT(30-1)-3682; AT-(30-1)-2047. 39p. Dep. CFSTI.

Theoretical investigations of radiation effects in ionic crystals were conducted with the objectives of accounting quantitatively for the optical and magnetic properties of radioinduced defects, and of understanding other radiation effects. Energy levels were calculated by crystal-field theory for trapped-hole centers in Al_2O_3, including interstitial O^0, interstitial O^+, and substitutional O^- adjacent to a charge-deficient cation site. Energy levels and wave functions were also calculated for F and F′ centers and a postulated $(AlO)^{3-}$ defect. All of these models except the F′ center were found to correlate with observed optical and ESR spectra. An investigation of trapped N^0 in KN_3 suggests a different site from that originally reported. Related investigations were conducted including postulation of a theory for positive g shifts of F centers in divalent compounds, the calculation of wave functions for divalent anions, and a band-structure calculation for Al_2O_3. A rather different radiation effect which was studied involved channeling of energetic, heavy ions in scintillation counters. Development of a pseudopotential method for treating ion-size effects in color centers and a study of thermal ionization of F′ centers were initiated. (auth)

40683 (RISO-M-910) ELECTRON BEAM CURING OF SURFACE COATINGS. Batsberg Pedersen, W.; Singer, K. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 30, 1969. 31p. (In Danish). Dep.

A critical literature survey on electron beam curing of organic surface coatings including the patent literature is given. The most important conditions for obtaining a completely polymerized film, including the effect of radiation dose, chemical composition and degree of unsaturation of the prepolymer, the nature and amount of the crosslinking vinyl monomer, as well as the molecular weight of the prepolymer are discussed. Coatings based on unsaturated polyesters, acrylics, epoxy-modified acrylics, urethanes, or silicones are described. (auth)

40684 (UCLA-12-736) STUDIES ON THE CHEMICAL BASIS OF CELLULAR RADIOSENSITIZATION BY 5-BROMOURACIL SUBSTITUTION IN DNA. I. PULSE AND STEADY STATE RADIOLYSIS OF 5-BROMOURACIL AND THYMINE. Zimbrick, J. D.; Ward, J. F.; Myers, L. S. Jr. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT-04-1-GEN-12. 45p. Dep. CFSTI.

Pulse and steady-state radiolysis techniques were combined in a comparative study of the radiation chemistry of aqueous oxygen-free solutions of 5-bromouracil (BU) and thymine (T). The results show several important differences in the radiolysis of these two molecules, which may form the chemical basis of BU sensitization. The hydrated electron (e^-_{aq}), $\cdot CO_2^-$, and certain organic radicals destroy BU by reactions that yield a uracilyl radical and Br^-. In contrast, these species are not important in T destruction. The uracilyl radical is a transient species having a weak absorption maximum at 335 nm. It is very reactive, being able to abstract H· from a variety of molecules to form uracil and to propagate a chain reaction in formate BU solutions. (auth)

40685 GAS PHASE α-RADIOLYSIS OF HYDROGEN SULPHIDE. Forys, M.; Jezierska, K. (Warsaw Univ.). Radiochem. Radioanal. Lett., 1: 237-45(Aug. 13, 1969).

Gas phase α radiolysis of H_2S was studied. Hydrogen and elementary sulfur were the only stable products of the radiolysis. The effects of various scavengers and the influence of nitrogen concentration on the hydrogen yield were examined. Hydrogen yield did not depend upon the type of radiation and phase. (auth)

40686 INTRAMOLECULAR TRANSFER OF ENERGY IN LOW-TEMPERATURE RADIOLYSIS OF DIALKYL SULFIDES. Samoilova, R. I.; Andrievskii, V. N.; Tsvetkov, Yu. D. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Khim. Vys. Energ., 3: 285-6(May-June 1969). (In Russian).

Yields of free radicals, formed on irradiation of dialkyl sulfides, R−S−R, where $R = C_nH_{2n+1}$ (n = 1 to 8, 10, 16), were studied. The irradiations were carried out with ^{60}Co gamma radiation or 3.6-MeV electrons at 110 to 115°K. (M.C.G.)

40687 INVESTIGATION OF THE RADIOLUMINESCENCE OF LIQUID ORGANIC SCINTILLATORS IN STRONG ELECTRIC FIELDS. Berlin, Yu. A.; Gusynin, V. I.; Kasimovskaya, E. E.; Tal'roze, V. L. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 3: 284-5(May-June 1969). (In Russian).

The influence of an electric field on the main components of luminescence was studied at concentrations of phosphors typical of scintilllator solutions for practical applications. Constant and variable electric fields and ^{60}Co gamma radiation were used. All of the free charges were captured by the phosphor up to recombination. The electric field had no effect on the light yield of the solutions within the limits of error of the experiment, ±3%. (M.C.G.)

40688 MECHANISM OF FORMATION OF TRIPLET MOLECULES ON RADIOLYSIS. Batekha, I. G.; Alfimov, M. V.; Shekk, Yu. B. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 3: 282-3(May-June 1969). (In Russian).

The luminescence of solutions of naphthalene-d_8 in toluene at −180°C was studied following excitation by 12-keV electrons and by uv light. The luminescence was recorded for 10 sec and the dose rate was 0.01 MRAD/sec. (M.C.G.)

40689 CONCERNING THE RADIOTHERMOLUMINESCENCE OF ORGANIC COMPOUNDS. Tochin, V. A.; Nikol'skii, V. G. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 3: 281-2(May-June 1969). (In Russian).

The relation of maximum radiothermoluminescence of polyethylene and two rubbers to the initial concentration of charges was studied by irradiation of the polymers in a vacuum at 77°K using ^{60}Co gamma radiation. The concentration of charges changed in proportion to radiation dose and a linear relation between thermoluminescence and dose was observed for doses of less than 1 MRAD. (M.C.G.)

40690 KINETICS OF RADIOLYSIS OF ISOPROPYL ALCOHOL AT 77°K. Tikhomirov, L. A.; Martynova, A. A. Khim. Vys. Energ., 3: 279-80(May-June 1969). (In Russian).

For clarification of the mechanism of annihilation of radicals by radiation, investigations of the reaction kinetics of final products from radiolysis for different concentrations of stabilized radicals were necessary. The kinetics of accumulation of radicals and acetone on low-temperature radiolysis of isopropyl alcohol were studied for a wide dose range. Acetone was the main product of the gamma radiolysis at 0.083 MRAD/min. (M.C.G.)

40691 RADIOLYSIS OF CHILLED AQUEOUS SOLUTIONS OF HYDROBROMIC AND HYDRIODIC ACIDS. Borisova, E. N.; Bugaenko, L. T. (Moscow State Univ.). Khim. Vys. Energ., 3: 278-9(May-June 1969). (In Russian).

Data are presented concerning the formation of optical centers on irradiation of vitreous hydrobromic and hydriodic acids at 77°K with 60-kV x rays. Spectra were recorded and compared with the spectra of the corresponding trihalide ions in the same matrix at 77°K. (M.C.G.)

40692 PROCESSES OF ELECTROCHEMICAL OXIDATION IN IRRADIATED SOLUTIONS OF SODIUM NITRATE. Kalmykov, L. Z.; Vasil'ev, A. G.; Bail, E. I. (Kharkov Scientific Research Inst. of Medical Radiology. Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 259-64(May-June 1969). (In Russian).

In order to clarify the possibilities of utilization of aqueous solutions that contain oxidizing-reducing ion pairs for electrochemical studies of dose rate, the processes of oxidation by dc electric current of products from radiolysis of aqueous solutions of sodium nitrate were studied. On the action of gamma radiation on the electrochemical system, a stationary current potential was established that was directly proportional to the dose rate in the range studied, up to 3000 R/sec. (tr-auth)

40693 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF FLUOROALKYL MACRORADICALS IN IRRADIATED POLYTETRAFLUOROETHYLENE AT 77°K. Asaturyan, R. A.; Muromtsev, V. I.; Bruk, M. A.; Abkin, A. D. Khim. Vys. Energ., 3: 256-8(May-June 1969). (In Russian).

In spite of the fact that the EPR spectrum of $\sim CF_2\dot{C}FCF_2 \sim$ macroradicals at room temperature and above is well known, the spectrum at low temperature was not established. On the basis of differences in the temperatures of extinction and relaxation times of radicals of different types, formed on gamma-irradiation of polytetrafluoroethylene, the spectrum of the $\sim CF_2\dot{C}FCF_2 \sim$ macroradical at 77°K was isolated. (tr-auth)

40694 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF FLUOROALKYL MACRORADICALS IN GAMMA-IRRADIATION OF TETRAFLUOROETHYLENE AT 4.2°K. Muromtsev, V. I.; Asaturyan, R. A.; Bruk, M. A.; Abkin, A. D.; Akhvlediani, I. G. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 252-5(May-June 1969). (In Russian).

The EPR spectra of crystalline tetrafluoroethylene, recorded at the temperature of gamma-irradiation (4.2°K), is said to indicate the presence of fluoroalkyl macroradicals in the form $\sim CF_2\dot{C}FCF_2 \sim$. This result is an argument in favor of the formation of polytetrafluoroethylene in the course of the gamma-irradiation at 4.2°K. (tr-auth)

40695 TRANSITIONS OF FREE VALENCE IN IRRADIATED ALANINE-GLYCINE PEPTIDES. Panin, V. I.; Usatyi, A. F.; Molodov, L. A. Khim. Vys. Energ., 3: 248-51(May-June 1969). (In Russian).

EPR studies were made on free radical reactions in irradiated alanine-glycine peptides. In experiments with peptides containing alanine linkages at the N end of the molecule, changes in EPR spectra were observed. It is possible to explain these changes by change of localization of the free valence. Experiments with chilled solutions of the peptide series indicated the intermolecular character of the transition of the free valence. (tr-auth)

40696 ELECTRON PARAMAGNETIC RESONANCE SPECTRA AND RADICAL PAIR STRUCTURE IN γ IRRADIATED DIMETHYLGLYOXIME MONOCRYSTALS. Yakimchenko, O. E.; Doroshina, G. P.; Lebedev, Ya. S. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 3: 242-7(May-June 1969). (In Russian).

The EPR spectra of γ-irradiated dimethylglyoxime monocrystals were studied at 77°K at different orientations in a magnetic field. By comparison of theoretical and experimental angular relations the fine spallation constant was established. In addition to the radical pairs previously studied, five radical pairs with identical chemical structure but different in reciprocal location are formed with mean distances of 4.9, 4.6, 4.5, 3.9, and 3.2 Å. (tr-auth)

40697 ACTION OF GAMMA RADIATION ON RUBBERS IN VACUUM IN THE PRESENCE OF STABILIZERS. Bol'shakova, S. I.; Degteva, T. G.; Kuz'minskii, A. S. (Scientific-Research Inst. of Rubber Industry, Moscow). Khim. Vys. Energ., 3: 236-41(May-June 1969). (In Russian).

The protective action mechanism of a secondary aromatic amine (phenyl-β-naphthylamine) on the radiolysis of nitrile rubber in a vacuum was studied. The consumption of the amine on irradiation was connected to the presence of oxygen-containing groups (which are accumulated in the process of storage) in rubber molecules. After the removal of the oxygen-containing groups the consumption of the amine in the gamma irradiation was not observed. The radiation protection of the rubber by the small addition of aromatic amine is explained by the migration of excitation energy from the rubber to the addition, which is capable of dispersing it without undergoing any other chemical changes. The same rules were observed in the formation of cross bonds in the rubber-amine system as in the solid-phase radiolysis of low-molecular-weight hydrocarbons. The thermal vulcanization behavior, subjected to the constant deformation of compression (20%) showed that the presence of aromatic amine did not effect the process of chemical relaxation of stress, but decreased the accumulation of irreversible residual deformation. The possible mechanism of the process was examined. (tr-auth)

40698 RADIATION-CHEMICAL SYNTHESIS OF DIALKYLTIN DIBROMIDE. I. MICROKINETIC RULES OF DIBUTYLTIN DIBROMIDE SYNTHESIS. Miretskii, V. Yu.; Vereshchinskii, I. V.; Ivanov, A. Yu. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., 3: 231-5(May-June 1969). (In Russian).

The main rules for the synthesis of dibutyltin dibromide under the action of γ radiation are described. The experimental conditions used in the study consisted of an intensive stirring apparatus. The induction period of the reaction can be studied by previous treatment of tin with hydrochloric acid and by the introduction of activating additions to the reaction system. The influence of component ratio, temperature, and dose rate on the reaction rate was studied. The reaction rate was found to be proportional to the square root of the dose rate. The effective energy of activation of the reaction in the temperature range 40 to 95° was 6.2 kcal/mole. The influence of inhibitors such as benzoquinone, hydroquinone, etc., was studied in the concentration range 10^{-4} to 10^{-2} moles/g. The assumption was made that the dibutyltin dibromide formation reaction proceeds according to the radical chain mechanism. This is confirmed by the large radiation yield (10^3 to 10^4 molecules per 100 eV) and by the behavior of the reaction system upon the introduction of activating and inhibiting additions, and by the relationship of the reaction rate to the absorbed dose rate. (tr-auth)

40699 RECOMBINATION OF RADICALS IN IRRADIATED GLYCERIN. Ermolaev, V. K.; Milov, A. D.; Tolkachev, V. A. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Khim. Vys. Energ., 3: 224-30(May-June 1969). (In Russian).

The recombination of radicals in crystalline glycerol begins at temperatures of 170° below the melting point and occurs in two temperature regions: 120 to 210°K and in the premelting region (230 to 290°K). The peculiarities of radical extinction was determined by freezing conditions and by the quantity of water in the forms. A recombination model is proposed for the premelting region. It is expected that in absolute glycerol up to 90% of the radicals recombine on melting. The presence of water has an effect on the rate of reaction constant of the recombination in amorphous glycerol. (tr-auth)

40700 RADIOLYSIS OF ETHYLENE-AMMONIA MIXTURES. Dzantiev, B. G.; Shvedchikov, A. P. (Inst. of Chemical Physics, Moscow). Khim. Vys. Energ., 3: 217-23(May-June 1969). (In Russian).

The role of atomic hydrogen, produced by the radiation decomposition of molecules of ethylene and ammonia, in the formation of different hydrocarbon products, C_2 to C_{12}, was studied. The influence of the concentration of ethylene (the acceptor of the thermal hydrogen atoms) on the yields of hydrogen and hydrocarbon products was studied. The G-values depend on the composition of the irradiated mixture and follow the series $C_2 \approx C_4 > C_6 > C_8 > C_{12}$. It was supposed that in the radiation decomposition of the excited molecule NH_3^* approximately 10 to 15% of the hydrogen atoms generated constitute hot hydrogen atoms. (tr-auth)

40701 CHARGE OF RECOIL ATOMS IN THE α DECAY OF ^{223}Ra. de Wieclawik, Wladyslaw (Institut de Physique Nucleaire, Orsay, France). Compt. Rend., Ser. B, 268: 1268-71(May 12, 1969). (In French).

The recoil atoms $^{219}Rn^{n+}$ have a mean charge $n_1 = 12.5$ or $n_2 = 18.5$ according as the α decay of $^{223}Ra(AcX)$ is followed by a single internal conversion or by a cascade of two internal conversions; the two distributions centered on n_1 or n_2 are of the same width. (tr-auth)

40702 RADIATION CHEMICAL INVESTIGATIONS WITH HYDROCARBONS AND SULFUR COMPOUNDS. I. ANALYSIS OF OXIDIZED SOLUTIONS OF HYDROCARBONS. Boberg, Friedrich; Guenter, Juergen; Striefler, Bernd; Quade, Peter (Institut fuer Erdoelforschung, Hanover). Erdoel Kohle, 22: 77-80(Feb. 1969). (In German).

The radiolytic oxidation of hydrocarbons produces mixtures containing hydroperoxides. Two methods are used for the analysis of such mixtures. In the first the hydroperoxides are decomposed in a reproducible manner; in the other conditions are chosen to avoid decomposition. The first method is based on a titration of the hydroperoxides; cumene irradiated with O_2 for 163 hr at 75°C and 0.75 MRAD/hr is used as an example. The second is achieved by direct gas chromatographic analysis on a Teflon column; linearity of response for the principal irradiation products is demonstrated. Illustrative examples of typical mixtures of oxidation products including the hydroperoxides are presented as chromatograms of test solutions. A specially designed injection system is described and illustrated. (BBB)

40703 RADIATION CHEMISTRY OF PROPANOL. PART II. CORRELATION OF MASS SPECTRAL AND RADIOLYSIS DATA. Basson, R. A.; van der Linde, H. J. (Atomic Energy Board, Pretoria). J. Chem. Soc., A, No. 11, 1618-20(1969).

In addition to hydrogen, propionaldehyde, and hexanediol, the following products were found in irradiated propanol: formaldehyde (G 1.9), acetaldehyde (0.1), methane (0.14), ethylene (0.35), ethane (2.0), propylene (0.13), and propane (0.25). By use of a modified fragmentation pattern, the mass spectrum of propanol is applied to calculating theoretical radiation chemical yields. When dissociations of neutral excited molecules are taken into account, good agreement between experiment and theory is obtained. (auth) (UK)

40704 RADIATION-CURED CASTABLE ELASTOMERIC POLYURETHANES AND POLYTHIOETHERS. Klotz, Morton A.; Carleton, L. T.; Saltonstall, C. W.; Kispersky, J. P.; Phillips, R. E.; Grakauskas, Vytautas; Mishuck, Eli (Aerojet General Corp., Azusa, Calif.). Ind. Eng. Chem., Prod. Res. Develop., 7: 165-9(Sept. 1968).

The potential advantages of γ radiation for curing, or cross-linking, castable elastomers were explored. When elastomeric polyurethane castings were prepared by ^{60}Co irradiation of liquid unsaturated polyurethanes at a dose of 7.5×10^5 RAD/hr, no comonomer was required. The best elastomers were produced from tolylene diisocyanate, polypropylene glycol, and glyceryl monolinoleate. The tensile strength, crosslink density, and H (cross-linking) were roughly inversely proportional to the concentration of unsaturated diol. The efficiency of the cross-linking reaction increased as the concentration of the cross-linking agent decreased. G (cross-linking) ranged from 64 to 145, consistent with a vinyl polymerization mechanism of short chain length. The cross-link yield, moles of cross-links per mole of unsaturated diol, ranged from 0.24 to 1.37; the latter figure suggests that both double bonds of the linoleate chain entered into the reaction. Strong elastomers were prepared by the reaction of long-chain dithiols with long-chain diolefins, using triolefins or long-chain trithiols as cross-linking agents. Free-radical initiators gave erratic behavior, and uv irradiation could not be used because of opacity, but γ-radiation from a ^{60}Co source gave excellent results. Swelling ratios, sol fractions, and tensile strengths were measured as a function of radiation dose. The reaction of a diolefin with a dithiol followed second-order kinetics, with an initial G value for the formation of thioether bonds of 4560 per 100 eV. The G value decreases with increasing extent of reaction. When the reaction is 95% complete, G (thioether bonds) is of the same order of magnitude as G (C–H), so that decomposition becomes a competing reaction. (BBB)

40705 IRRADIATION PROCESS AND APPARATUS. Jadot, Andre; Saint-Lebe, Louis (to Commissariat a l'Energie Atomique). British Patent 1,158,835. July 23, 1969. Priority date Aug. 19, 1966, France.

A method is described for irradiating a material by placing the material in a container formed as a thin flexible or jointed band and moving the band linearly in a given circuit parallel to a fixed plane round the radiation source. Reciprocating motion which is perpendicular to the fixed plane around the source, is also provided between the band and the source, so that the resultant relative movement between the band and source is sinusoidal. The apparatus for performing the irradiation comprises a column for supporting a plate having rollers with axes perpendicular to the plane of the plate. One of the rollers is hollow for receiving a radioactive source. The flexible or joined band-like container for the material to be irradiated is disposed around the rollers, which drive the material past the radioactive source. (B.L.M.)

40706 EFFECT OF THE CONDITIONS OF IRRADIATION ON THE PROPERTIES OF MINERAL OILS. Shor, G. I.; Stukin, A. D.; Gorbach, V. A. Khim. Tekhnol. Topliv Masel, No. 9, 46-50(1967). (In Russian).

Effects of irradiation by a ^{60}Co source of SU oil (a Baku oil) and IS-45 (a sulfur-containing oil) were studied. Fractions of SU showed increased viscosity after doses up to 10^9 RAD (naphthene-paraffins, 500%; light aromatics, 250%). Evolution of gas increased linearly with dose for these two fractions at doses up to 10^8 RAD; at 8×10^7 RAD the evolution was 5 ml/ml for naphthene and 2 ml/ml for aromatics. The temperature of irradiation of SU produced a variance in the viscosity at 50°C for a dose of 10^8 RAD: a 5% increase was found for irradiation at −200°C, 10% at 40°C, and 50% at 190°C. The dependence of viscosity changes of the naphthene fraction of SU on its aromatic hydrocarbon content was found: a concave curve from 650% increase at 0% aromatic to 180% increase at 100% aromatic. The maximum radiation changes occurred at a dose rate near the lower limit studied, 650 RAD/sec. (BBB)

40707 EFFECT OF THE TYPE OF IONIZING RADIATION ON THE RADIATION CHARACTERISTICS OF PETROLEUM OILS. Stukin, A. D.; Shor, G. I.; Gorbach, V. A.; Ryaboshapko, A. G. Khim. Tekhnol. Topliv Masel, No. 1, 47-50(1969). (In Russian).

Samples of Baku oil SU, IS-45 oil, and the naphthene-paraffin fraction of SU were irradiated with corresponding doses in the V.N.I.I. N.P. ^{60}Co source and in the T.V.R. nuclear reactor. Viscosity of the naphthene fraction at 50°C increased from 38 ccm at 0 MRAD to 180 ccm (T.V.R.) or 340 ccm (^{60}Co) at 1000 MRAD. Molecular weight of this fraction increased from 450 to 575 (T.V.R.) or 650 (^{60}Co) at 1000 MRAD. The index of refraction of this fraction increased from 1.481 to 1.489 (T.V.R.) or 1.494 (^{60}Co) at 1000 MRAD. Density of this fraction increased from 0.880 to 0.897 (T.V.R.) or 0.902 (^{60}Co) at 1000 MRAD. Content of unsaturated hydrocarbons in this fraction increased from 0 to 13% by weight (T.V.R.) or 24% (^{60}Co) at 1000 MRAD. Variables are collected for all samples and fit to linear or exponential equations; coefficients for the lines of best fit are tabulated. (BBB)

40708 CONCERNING THE RADIATION METHOD OF OBTAINING SEPTIVALENT NEPTUNIUM AND PLUTONIUM. Pikaev, A. K.; Shilov, V. P.; Krot, N. N.; Gel'man, A. D.; Spitsyn, Vikt. I. Izv. Akad. Nauk SSSR, Ser. Khim., No. 5, 1199(May 1969). (In Russian).

Solutions of Np(VI) or Pu(VI) perchlorates in 1M NaOH were saturated with nitrous oxide and subjected to gamma radiation. Practically complete transformation of Np(VI) and Pu(VI) to Np(VII) and Pu(VII) occurred at doses of 9×10^{18} and 1.8×10^{19} eV/ml. In solutions saturated by air oxidation was not observed. It was concluded that formation of Np(VII) and Pu(VII) proceeds at the expense of O^- ion radicals. (M.C.G.)

40709 REDISTRIBUTION REACTION OF RADICALS UNDER CONDITIONS OF GAMMA-IRRADIATION (^{60}Co). Kocheshkov, K. A.; Makhina, A. A.; Zemlyanskii, N. N.; Panov, E. M. Izv. Akad. Nauk SSSR, Ser. Khim., No. 6, 1381-2(June 1969). (In Russian).

The possibility of redistribution reactions of radicals between germanium tetrachloride and tetramethyl-, tetraethyl-, and tetrabutyltin under gamma-irradiation at room temperature was investigated. (tr-auth)

40710 LOW-TEMPERATURE PHOTOTRANSFORMATION IN γ-IRRADIATED β-ALANINE MONOCRYSTALS. Shul'ga, S. Z.; Lisovenko, V. A. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 14: 676-9(Apr. 1969). (In Russian).

Graphical data show the variations in optical and EPR spectra in γ-irradiated β-alanine monocrystals illuminated by white light at 77°K. (R.V.J.)

40711 RADICAL FORMATION IN THE RADIOLYSIS OF SOLID ISOBUTANE AS STUDIED BY ESR SPECTROSCOPY. Wakayama, Terunobu; Miyazaki, Tetsuo; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap., 42: 1164(Apr. 1969).

An ESR study was made of the radicals produced in γ-irradiated isobutane with and without additives at 77°K. When carbon tetrachloride was added to the isobutane, a drastic change occurred in the spectrum, and the yield of isobutyl radicals decreased and that of CCl_3 radicals increased with increasing concentration of carbon tetrachloride. The radical formation in γ-irradiated isobutane containing ethyl iodide was also investigated. The yield of isobutyl radicals did not change significantly with increasing concentration of ethyl iodide. The addition of electron scavengers such as nitrous oxide and sulfur hexafluoride also did not cause a change in the yield of isobutyl radicals. Results indicate that in the radiolysis of solid isobutane the isobutyl radical is not produced from the neutralization reaction, but mainly from the decomposition of directly excited isobutane molecules or ions, and that energy transfer from isobutane to carbon tetrachloride plays a role in suppressing the decomposition of isobutane. (D.H.M.)

40712 USE OF RARE EARTH COMPLEXES WITH DETHYLENETRIAMINEPENTAACETIC ACID (DTPA) AS TARGET FOR IRRADIATION WITH 660-MeV PROTONS. Beyer, G. J.; Grosse-Ruyken, H.; Khalkin, V. A.; Pfrepper, G. (Joint Inst. of Nuclear

Research, Dubna, USSR). J. Inorg. Nucl. Chem., 31: 2135-40 (July 1969). (In German).

Solid complex compounds of lanthanides with diethylenetriaminepentaacetic acid (DTPA) were exposed to 660-MeV protons for preparing pure samples of short-lived neutron deficient isotopes of the rare earths. The larger fraction of spallation reaction products stabilizes in the RE^{3+}-ion fraction based on the Szilard—Chalmers effect. This fraction is easily separated from the target complex with a yield of 50 to 70% and enrichment factors of 300 to 450. The proposed methods, including a chromatographic separation, allow commencement of nuclear spectroscopic investigations with solid state detectors 12 to 15 min after irradiation. Radiolysis and retention were also investigated. (auth) (UK)

40713 FORMATION OF EXCITED SINGLET STATES IN THE NANOSE PULSE RADIOLYSIS AND NANOSECOND FLASH PHOTOLYSIS OF AROMATIC MOLECULES IN LIQUID AND SOLID SOLUTIONS. **Thomas J. K. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 770-8(July 15, 1969).**

The absorption spectra of the excited singlet states of naphthalene and 1 : 2 benzanthracene were observed in the nanosecond pulse radiolysis and flash photolysis of these solutes in cyclohexane, benzene, and polystyrene. The effect of xenon, piperylene, and excimer formation on the absorption spectra provides evidence for the assignment of these spectra to excited singlet states. The spectra are very similar both in shape and intensity to the triplet spectra; hence, little growth of the triplet state is observed as the excited singlet state decays. An extinction coefficient at 560 mμ for the 1 : 2 benzanthracene excited singlet is measured as $\epsilon 560 = 9700 \underline{M}^{-1} \cdot cm^{-1}$. Using the photolysis data it is shown that approximately equal yields of excited singlet and triplet states are initially formed in the radiolysis of these systems. Large yields of ions were also formed in the pulse radiolysis of 1 : 2 benzanthracene in polystyrene and poly(methylmethacrylate). (auth)

40714 AN E.S.R. STUDY OF THE RADICAL FORMED ON ELECTRON IRRADIATION OF MESITYLENE ADSORBED IN A MOLECULAR SIEVE. **Heicke, G. A.; Fantechi, R. (EURATOM-CCR, Ispra, Italy). Mol. Phys., 17: 65-74(1969).**

Mesitylene adsorbed in a Linde 13 X molecular sieve was studied by ESR techniques during fast-electron irradiation at temperatures ranging from −45 to +10°C (freezing point of mesitylene: −52.7°C). A transient spectrum was obtained which consisted of a large (86.5 G) doublet splitting, plus another doublet (22.6 G), a septet (8.15 G), and a triplet (5.95 G). This spectrum was interpreted as arising from a radical produced by hydrogen addition to a methyl position in the mesitylene molecule. Tentative calculations suggest that the 86.5 G doublet splitting is consistent with the structure assumed for the radical. A non-transient spectrum of five broad lines was also observed, but its origin has not been identified. (auth) (UK)

40715 RADIATION PROTECTION BY THIOUREAS. **Wheeler, O. H.; Ribot, R. A. (Univ. of Puerto Rico, Mayaguez). Chem. Ind. (London), No. 30, 1017(July 26, 1969).**

Thiourea is known to be an effective radiation protector for macromolecules, and its reactivity as a radical scavenger is attributed to the presence of a thiol/thione equilibrium. A study of the relative reactivity of methylthioureas and related compounds is briefly described. The presence of one methyl group reduced the protecting activity of thiourea from a value of 33.5 to 6.2. Two or four methyl groups resulted in a further reduction in activity. The inductive effect of the methyl groups reduces the ease of ionization of the H-atoms on the N-atoms and also increases the polarity of the C = S bond, thereby reducing the amount of thiol form present. The thione form was about six times less reactive than the thiol tautomer. (UK)

40716 ATOMIC RADIOBROMINE IN NEUTRON-IRRADIATED p-DIBROMOBENZENE. Dancewicz, D.; Halpern, A. (Inst. of Nuclear Research, Warsaw). Radiochim. Acta, 12: 52-3(July 1969).

Thermal annealing in neutron-irradiated p-dibromobenzene was studied. Yields of atomic radiobromine and water extractable radiobromine were determined by dissolving the target in 1,2-dibromoethylene. Yields of water extractable bromine were not affected by isothermal heating, while those of atomic bromine decreased and reached a pseudoplateau, which depended on temperature. Apparently the inorganic activity consists of free bromine atoms $^{82}Br_{at}$ and of water extractable bromine, which corresponds to $H^{82}Br + {}^{82}Br_2$, but only the former fraction is involved in annealing. (J.G.B.)

40717 PREPARATION OF A ^{68}Ga GENERATOR. Karpeles, Alfredo (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 12: 22-5(July 1969). (In German).

^{68}Ge was prepared according to the reaction $^{69}Ga(d,3n)^{68}Ge$ by bombardment with 30-MeV deuterons. The use of a thick Ga_2O_3 target resulted in a yield of 1.7 μCi/μAh. After dissolution of the target and separation of the carrier free Ge-activity by ion exchange this is adsorbed on an aluminum oxide column and ^{68}Ga is eluted with complexing agent solutions which can be used immediately for intravenous injections. (auth)

40718 CHEMICAL BEHAVIOR OF ^{56}Mn PRODUCED BY (n,γ) REACTION IN ALKALI METAL PERMANGANATES. Shiokawa, Takanobu; Yagi, Masuo; Sasaki, Teikichi (Tohoku Univ., Sendai). Radiochim. Acta, 12: 54(July 1969).

It was found that the thermal annealing processes and resulting chemical species of recoil ^{56}Mn are strongly dependent on the cation of the permanganate in the neutron irradiation of alkali metal permanganates. It is suggested that the order of ionization potential, Li > Na > K > Rb > Cs, might be responsible for differences in thermal annealing behavior. (J.G.B.)

40719 THE ISOTOPE AND PHASE EFFECTS ASSOCIATED WITH THERMAL NEUTRON CAPTURE IN HALOMETHANES. Abedinzadeh, Z. (CEA de Saclay, Gif-Yvette, France); Radicella, R.; Tanaka, K.; Milman, M. Radiochim. Acta, 12: 4-11(July 1969).

Mono-, di-, and tribromomethane were irradiated with thermal neutrons, and the total and fractional organic yields of ^{80m}Br and ^{82}Br were studied, as a function of bromine scavenger concentration. The results confirm the previous observations that the rupture of a C—Br bond requires kinetic energy which can equally well be furnished by ^{80m}Br and ^{82}Br. Hydrogen atom substitution seems to be a characteristic consequence of Auger processes and as such, is more easily caused by ^{82}Br. The phase effects were difficult to interpret but helped in understanding some of the mechanisms connected with radical recombinations. (auth)

40720 EVIDENCE FOR THE FORMATION OF A P—N BOND IN THERMAL-NEUTRON IRRADIATED AMMONIUM AND CALCIUM HYPOPHOSPHITES DISSOLVED IN AQUEOUS SOLVENT AND LIQUID AMMONIA. Anselmo, Vincent C.; Sanchez, Ernest (New Mexico Highlands Univ., Las Vegas). Contracts W-7404-eng-36; AT(11-1)-1618. Radiochim. Acta, 12: 17-20(July 1969).

In the study of ammonium hypophosphite irradiated with thermal neutrons, two new activities were observed that are attributed to nitrogen-containing phosphorus oxy-anions. In another series of experiments, calcium hypophosphite, similarly irradiated, showed two additional species on solution in liquid ammonia. A mechanism is suggested which is consistent with the hot-zone model for hot atom reactions and subsequent reactions between fragments in the solid or between the fragments and the solvent. (auth)

40721 PREPARATION OF ^{18}F IN A NUCLEAR REACTOR. Mirza, M. Y. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). Radiochim. Acta, 12: 21-2(July 1969).

^{18}F was produced by $^{16}O(t,n)^{18}F$ reaction. The procedure was modified for the purification of carrier-free ^{18}F based on the adsorption on alumina and elution with 0.1$\underline{N}$ NH_4OH solution. Ninety percent of ^{18}F activities can be recovered in less than 10 min. (auth)

40722 ARRANGEMENT FOR PULSE RADIOLYSIS AT HIGH PRESSURE. **Schindewolf, U.; Lang, G.; Kohrmann, H. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Chem.-Ing.-Tech., 41: 830-2(July 1969). (In German).**

An apparatus is described, which was used for investigation of the absorption spectra and reaction kinetics of hydrated electrons produced by pulse radiolysis at pressures up to 1000 atm. The high-pressure system, the optical system, and the linear accelerator are described. Sensitivity of the arrangement is discussed. (M.C.G.)

40723 RADIATION POLYMERIZATION OF ACRYLONITRILE AT 4°K. **Danon, Jeanne; Dworkin, Ary; Roussel, Michel (Faculte des Sciences, Orsay, France). J. Chim. Phys., 66: 879-88(May 1969). (In French).**

Radioinduced polymerization of acrylonitrile (AN) in its low-temperature solid phase was studied at 4 and 77°K. Polymer yield was measured by gravimetry and molecular weight by osmometry. The influence of dose and warming rate of the irradiated samples was also investigated. The results, qualitatively identical for the two temperatures, were compared to corresponding literature data. Polymer yields, molecular weights, and polymer chains were lower at 4 than at 77°K. The results are an indirect proof of AN polymerizing under irradiation at 4 as well as at 77°K. In fact, they show that post polymerization, which occurs between 153 and 190°K by a radical mechanism, is not the only process to happen. The total initiation yield, at both temperatures under study, is greater than post-polymerization initiation yield, as given by electron paramagnetic resonance literature data. The observed difference is small but certain, and represents in-source polymerization initiation yield. The latter seems to be little dependent of irradiation temperature in the studied interval — which is quite compatible with an anionic mechanism. Post-polymerization initiation yield was smaller at 4 than at 77°K — which is also in agreement with the generally assumed mechanism for this process. Qualitative indications about variation between 4 and 77°K of other characteristics (polymer yield and molecular weight) for both discussed processes were obtained elsewhere. It was deduced from them that when irradiation temperature is lowered, the local increase of temperature, which results from dissipation in the solid of the reaction heat, is less favorable to the propagation reaction. (auth)

40724 RADIOCHEMISTRY OF HYDROCARBONS. 14. POSSIBLE RADICAL REACTIONS IN BENZENE. Zimmerli, Bernhard; Gaeumann, Tino (Eidgenoessische Technische Hochschule, Lausanne, Switzerland). Helv. Chim. Acta, 52: 764-76(1969). (In German).

The effect of ^{60}Co γ radiation at 0.5 MRAD/hr on benzene and its mixtures with naphthalene, anthracene, cyclohexene, and cyclohexadienes was examined. The main products in the monomer class from benzene radiolysis were cyclohexadiene-1,4 and -1,3. The G values ($\times 10^3$) for the radiolysis products of benzene at 25°C were as follows: hydrogen 36, acetylene 19, cyclohexadiene (1,4) 19, cyclohexadiene (1,3) 9, bicyclohexadiene 20, 5-phenylcyclohexadiene (1,3) 21, 3-phenylcyclohexadiene (1,4) 37, biphenyl 48, and total polymer 1120. A mechanism to account for this product formation in pure benzene is proposed and discussed. It is mainly based on radical reactions between cyclohexadienyl and phenylcyclohexadienyl radicals. The existence of phenyl radicals is shown by the formation of phenylnaphthalenes with naphthalene as additive. The observed inhibiting effect of cyclohexene and cyclohexadiene on biphenyl and phenylcyclohexadiene formation was explained by hydrogen abstraction by the phenyl radicals. (BBB)

40725 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. XXIV. THE POLYMERIZATION OF CETYL VINYL ETHER. Hardy, Gy.; Nyitrai, K.; Cser, F.; Cselik, Gy.; Nagy, I. (Research Inst. for Plastics, Budapest). Eur. Polym. J., 5: 133-44(Feb. 1968).

The γ-induced solid-state polymerization of a vinyl monomer, which has a long aliphatic substituent and cannot be polymerized otherwise than by a cationic mechanism, was studied. Under the influence of radical initiators (benzoyl peroxide, azobis[isobutyronitrile], irradiation for 15 hr with a 500-W output industrial mercury lamp, or with a 30-MRAD dose of γ irradiation at 25°) the cetyl vinyl ether did not polymerize in the liquid phase. On the other hand, polymer was formed in the liquid phase as a result of additives which promote cationic polymerization (solutions of 0.01% $FeCl_3$, 1% $AlCl_3$, and 1% BF_3 in ether). This is evidence that the cetyl vinyl ether is unable to polymerize by other than a cationic reaction. The polymers obtained showed an optical birefringence and melted sharply at 36°C. The structure of the polymer reflected that of the monomer matrix. This feature disappeared only after melting the system. The degree of polymerization of the polymers did not depend on the polymerization parameters (temperature, γ radiation dose rate), but was governed by the size of the crystal sections, which are perfect from the viewpoint of polymerization linkage. (BBB)

40726 OXYGEN EFFECT IN ANNEALING OF RECOIL DAMAGE IN BIS-SALICYLALDEHYDETRIETHYLENE TETRAMINE COBALT(III) CHLORIDE IN HYDRATE AND ANHYDROUS FORMS. Rao, K. Annaji (Bhabha Atomic Research Centre, Bombay). Radiochim. Acta, 12: 11-14(July 1969).

Annealing characteristics of neutron irradiated bis-salicylaldehyde-triethylene tetramine cobalt(III) chloride, 2.5 H_2O and the anhydrous complex at 150°, 180°, and 200°C in air and vacuum were studied. In contrast to the hydrate, at 150° oxygen almost completely inhibited annealing in the anhydrous complex. At higher temperatures the anhydrous complex also began annealing even in air, and showed a spurt in the rate of annealing after an induction period. Ethyl alcohol vapor ambient enhanced annealing in the hydrate but not in the anhydrous complex. On the basis of the electrons in traps model, the results with the anhydrous complex in air may be explained as due to the presence of oxygen as electron acceptor and to its desorption at higher temperatures. The absence of any enhancement in annealing in the anhydrous complex in the presence of the electron donor alcohol indicates that the electron transfer from the donor to the recoil cobalt takes place through the medium of water of hydration. (auth)

40727 ELECTRICAL CONDUCTIVITY OF 2-METHYLTETRAHYDROFURAN AND METHYLCYCLOHEXANE DURING WARMING FROM 77°K WITH AND WITHOUT PRIOR γ IRRADIATION. Ling, A. Campbell; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem., 73: 2408-12(July 1969).

The electric conductivity of unirradiated and γ-irradiated glassy 2-methyltetrahydrofuran (MTHF) during warming from 77°K shows that: (a) in the temperature range of ca. 87 to 100°K the MTHF dipoles can be significantly oriented by an electric field of 10^2 to 10^4 V cm^{-1}. When the field is removed in this temperature range, they undergo thermal randomization. Samples may be "field oriented" while cooling, to prevent orientation conductivity during warm-up from obscuring conductivity peaks induced by γ irradiation. (b) When a sample that has been field oriented is warmed following γ irradiation, electric conductivity peaks due to populations of trapped charged species are observable in the region from 77 to about 105°K. (c) Studies of radiation-produced, charged species at temperatures above about 105°K are precluded by the rapidly increasing intrinsic conductivity of MTHF as the temperature is raised in this range. Methylcyclohexane (MCHx), like 3-methylpentane (3MP) investigated earlier, has a sufficiently low intrinsic conductivity throughout the range from 77°K to the melting point at 247°K to allow use of the warm-up conductivity "spectrum" for study of temperature-dependent polarization and reorganization phenomena and of populations of charged species produced by γ irradiation. Such spectra were determined for polycrystalline MCHx and glasses containing 98% MCHx and 2% 3MP. (auth)

40728 REMOVAL OF DISSOLVED OXYGEN FROM AQUEOUS MEDIA BY IONIZING RADIATIONS. Evans, N. T. S. (Hammersmith Hospital, London). Radiat. Eff., 1: 19-22(Jan. 1969).

Tris-acetate buffer (0.14 *M*, pH 7), alone or containing *Shigella flexneri* in suspension, was irradiated with 250 kVp x rays or 7 MeV electrons in closed vessels or in vessels bubbled with gas containing oxygen. The removal of dissolved oxygen by the radiation was followed with a polarographic electrode. The rate of removal of oxygen at tensions below 5 mm Hg was 2.0 mm Hg/K rad with both electron and x irradiation of buffer solution. It was about 10% greater with Shigella in suspension. The rate of removal was lower at higher oxygen tensions, and the mean G_{-O_2} for oxygen removal between air tension and zero was 2.8, compared with 3.4 at all tensions below 5 mm Hg down to less than 0.2 mm Hg. Bubbling of the solution during irradiation did not alter the G-value significantly, since the fall in oxygen tension could be correlated well with the measured equilibration time constant of the solution and the G-value obtained in closed vessels. (auth)

40729 KINETICS OF RADIATION INDUCED THERMAL CRACKING OF PROPANE. Pereverzev, A. E.; Polak, L. S.; Chernyak, N. Ya. (Inst. of Petrochemical Synthesis, Moscow). Petrol. Chem. (USSR)(Engl. Transl.), 8: 181-7(1968).

Translated from Neftekhimiya, 8: 537-42(1968).

The activation energy of ^{60}Co radioinduced thermal cracking of propane was calculated for the temperature range of 350 to 480° and found to be 24 + 1 kcal/mole, which corresponds to the decomposition energy of the n-C_3H_7 radical. With a reduction in temperature the products obtained both by thermal cracking and radioinduced thermal cracking contained a higher proportion of methane decomposition products, which is mainly due to decomposition of n-C_3H_7 radicals. Using NO additives it was found that radioinduced thermal cracking at the temperatures indicated is mainly a radical-chain process that is initiated by radiation. (auth) (UK)

40730 RADIOLYSIS OF CYCLOHEXANE SOLUTIONS OF DUROQUINONE. Burr, J. G.; Goodspeed, F. G.; Warren, C. W. (North American Rockwell Corp., Thousand Oaks, Calif.). Radiat. Eff., 5-9(Jan. 1969).

The yields of hydrogen, cyclohexene, and bicyclohexyl are lower in gamma irradiated solutions of duroquinone in cyclohexane than they are in cyclohexane alone; duroquinone is consumed during the radiolysis. Product yields are functions of the duroquinone concentration; values at 75 mM duroquinone are: $G(H_2) = 3.50$; $G(C_6H_{10}) = 0.70$; $G((C_6H_{11})_2) = 0.21$; $G(-DQ) = 7$. The product from the quinone is shown to be probably a quinone containing a substituted cyclohexyl group. Duroquinone solutions in cyclohexane are photochemically inert, and duroquinone is not consumed in irradiated benzene solution. The reduction of hydrogen yield by duroquinone is attributed to electron scavenging; the reduction of cyclohexene and bicyclohexyl yields and the consumption of duroquinone is attributed to scavenging of cyclohexyl radicals (by hydrogen abstraction from the duroquinone methyl groups). The yield of cyclohexyl radicals in duroquinone-quenched solution is thus found to be 5.5 to 6.8, and their origin is attributed to the reactions of "hot" (unscavengable) hydrogen atoms. (auth)

40731 ELECTRON BEAM RADIATION CURING OF LIQUID MERCAPTAN TERMINATED BUTADIENE-ACRYLONITRILE COPOLYMERS. Brenner, W. (New York Univ., N. Y.); Adler, A.; Kapfer, W.; Oliver, W.; Drake, R. Sci. Advan. Mater. Process Eng. Proc., 14: Paper II-5A-2(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

The electron beam radiation curing of mercaptan terminated liquid butadiene–acrylonitrile polymer (Hycar MTBN) at ambient temperatures and in the presence of air provided a product with a dry shiny surface. A good cure was obtained with films less than 10 mils thick and doses of 25 to 30 Mrad. Tests were also made on heavier samples (35 to 50 mils thick). Data on properties of the cured films are tabulated. It was concluded that radiation curing of Hycar MTBN can result in substantial reductions in handling costs and much greater processing convenience as well as almost instantaneous curing speeds. (P.C.H.)

40732 REDUCTION OF URANYL NITRATE IN TRIETHYL AND TRIPROPYL PHOSPHATES. Dziegelewski, J.; Jezowska-Trzebiatowska, B.; Kalecinski, J. (Inst. of Low Temperatures and Structural Research, Wroclaw. Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 239-44(1969).

Studies were made on the kinetics of the reduction of uranyl compounds in triethyl (TEP) and tripropyl phosphate (TPP) by γ radiolysis. Special attention was given to changes in the reduction mechanism and yields according to the type of alkyl group. An induction period was found in the aerated solutions of uranyl nitrate in TPP, but none was observed in solutions saturated with H. In TEP, however, the induction periods appeared in both aerated and hydrogen-saturated solutions. No induction period was observed during irradiation of nitrogen-saturated uranyl chloride solutions in TEP. This suggests that the nitrate ions are responsible for the induction period. Studies also showed that the solvated electron is the strong U(VI) reducing agent in TPP solutions. (P.C.H.)

40733 ACTIVATION ENERGIES FOR REACTIONS OF THE HYDRATED ELECTRON. Arcek, B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 223: 491-2(Aug. 2, 1969).

The pulse radiolysis technique was used to measure the rate of decay of the e_{aq}^- absorption at 650 mn after a pulse of 50 to 100 R, at temperatures from 15 to 80°C, using various aqueous systems. A correction was applied for the effect of temperature on the decay of e_{aq}^- in water itself. Activation energies were calculated from the slopes of the Arrhenius plot. Reproducibility of rate constants and activation energies was to within 10%. Solutes studied were pyridine, bromouracil, iodouracil, acrylamide, p-bromophenol, p-nitrophenol, and nitrobenzene. Reaction mechanisms are postulated for the reactions of bromouracil and iodouracil with e_{aq}^-, and it is suggested that dehalogenation proceeds by dissociative electron attachment. It was concluded that the reactions of e_{aq}^- do not show a constant energy of activation of 3.5 kcal/mole, as previously implied, but that the rate constants are determined not only by the entropy of activation, but also by the enthalpy of activation. (UK)

40734 REDUCTION OF URANYL NITRATE IN n-BUTANOL. Dziegielewski, J.; Kalecinski, J. (Inst. of Low Temperatures and Structural Research, Wroclaw. Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 233-8(1969).

Studies on the reduction yields of U(VI) in the γ radiolysis of uranyl nitrate in n-butanol were compared with previous results in TBP. The yields for both aerated and hydrogen-saturated solutions increased with an increase in initial uranyl nitrate concentration. The reduction yield of U(VI) in butanol was about one-third higher than in TBP. The mechanism for reduction yields is discussed. It was found that the reduction of U(VI) proceeds through U(V), and, apart from the solvated electrons, some other intermediates (radicals and excited solvent molecules possessing reducing properties) are involved in the reduction. (P.C.H.)

40735 THE RATE OF REACTION BETWEEN NITROSYL-PENTACYANOCHROMATE(III) AND HYDROXYL RADICALS IN GAMMA-RADIOLYSIS. Jezowska-Trzebiatowska, B.; Kalecinska, E.; Kalecinski, J. (Univ., Wroclaw. Inst. of Low Temperatures and Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 225-31(1969).

Studies were made on the γ radiolysis of nitrosylpentacyanochromate(III) for comparison with previous results on nitroprusside. The NO group is more electronegative in nitrosylpentacyanochromate (III) than in nitroprusside. The rate constant $k_{OH+Cr(CN)_5NO^{3-}}$ was determined by the competition method with p-nitrosodimethylaniline (PNDA). It was found that the rate constant of the reaction is more than two orders of magnitude higher than that of the corresponding reaction of nitroprusside. The results confirmed that the following reaction $Cr(CN)_5NO^{3-} + OH \rightarrow X_1$ leads to the decomposition of $Cr(CN)_5NO^{3-}$. (P.C.H.)

40736 THIN LAYER CHROMATOGRAPHY AS A METHOD FOR INVESTIGATION OF RADIATION CHANGES IN ADSORBENTS AND ADSORBATES. Nowak, Zofia (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 14: 621-30(1969). (In Polish).

Thin layer chromatography was used to examine the permanent changes in adsorptive properties of some materials of chromatographic interest induced by γ radiation. The materials studied included: $Al(OH)_3$, Al_2O_3, and $5 : O_2$. On the basis of changes in R_T of selected compounds it was found that basic oxides increase their adsorptive properties under the influence of γ radiation. On the other hand adsorptive properties of acidic oxides decrease under these conditions. pH changes in irradiated adsorbents were also noted. EPR spectra of irradiated adsorbents were recorded at room temperature and at −196°, respectively. (auth)

40737 LOW-TEMPERATURE RADIATION CHEMISTRY. I. PREPARATION OF OXYGEN FLUORIDES AND DIOXYGENYL TETRAFLUOROBORATE. Goetschel, Charles T.; Campanile, Vincent A.; Wagner, Charles D.; Wilson, J. Norton (Shell Development Co., Emeryville, Calif.). J. Amer. Chem. Soc., 91: 4702-7(Aug. 13, 1969).

Radiolysis of liquid mixtures of O_2 and F_2 at 77°K with 3-MeV bremsstrahlung produces a mixture of O_2F_2 and $(O_2F)_n$ with possibly small amounts of higher oxides. The mixture was converted to pure O_2F_2 at 195°K. Contrary to earlier reports, pure O_2F_2 is yellow, melts sharply at 119°K, and is diamagnetic. Infrared spectra were obtained of the unpurified product and of O_2F_2. In the radiolytic synthesis, the G value for generation of F atoms appears to be about 20. Data support the existence of O_2F_2, O_2F, O_4F_2, and unknown oxides of higher oxygen content. As previously reported by others, BF_3 reacts with either O_2F_2 or with mixtures of O_2F_2 and superoxygen fluorides to produce O_2BF_4; less stable compounds seem to be produced from the higher superoxides. The infrared and paramagnetic resonance spectra of O_2BF_4 were obtained; the x-ray powder pattern shows that the crystals are orthorhombic and isomorphous with $NOBF_4$. (auth)

40738 CHEMISTRY OF ^{128}I AND ^{130}I RECOILS IN NEUTRON-IRRADIATED CRYSTALLINE POTASSIUM IODATE AND POTASSIUM PERIODATE. Boyd, G. E.; Larson, Q. V. (Oak Ridge National Lab., Tenn.). J. Amer. Chem. Soc., 91: 4639-44 (Aug. 13, 1969).

Radioactive ^{128}I and ^{130}I recoils formed by neutron capture in crystalline KIO_3 and KIO_4 appeared as iodide, iodate, and periodate ions on analysis of alkaline aqueous solutions of the irradiated solids. With KIO_3 more than two-thirds of the radioiodine was retained as radioiodate, and small amounts of radioperiodate were found. With KIO_4 nearly 90% of the recoils appeared as radioiodate, while the periodate retention was slightly less than 10%. The relative concentrations of the radioiodine oxidation states varied with the time and temperature of the neutron bombardment. Radioiodide was readily converted to iodate and periodate on heating or on exposing the neutron-irradiated solids to ^{60}Co γ rays. Iodine-131 added in tracer concentrations to crystalline KIO_3 or KIO_4 as iodide ion was rapidly oxidized to iodate and to periodate on heating the solids above room temperature. There was only a small isotopic effect in the yields of the iodine valence states in which ^{128}I and ^{130}I were combined. (auth)

40739 KINETICS OF γ-RADIATION-INDUCED FREE-RADICAL CHAIN REACTIONS BETWEEN ALKANES AND CHLOROOLEFINS. II. SOLUTION OF TRICHLOROETHYLENE IN CYCLOHEXANE. Horowitz, A.; Rajbenbach, L. A. (Soreq Nuclear Research Center, Yavne, Israel). J. Amer. Chem. Soc., 91: 4631-4(Aug. 13, 1969).

The kinetics of the γ-induced free radical chain condensation reactions in solutions of trichloroethylene in cyclohexane were studied in the temperature range 27 to 150°C. The absolute rate constant for the addition of cyclohexyl radical to trichloroethylene at 150°C is estimated at $1.28 \times 10^5\ \underline{M}^{-1}\ sec^{-1}$, on the basis of the rate constant ratio obtained from kinetics taken together with alkyl radical combination data. The absolute rate constant for the scission of the chlorine atom from the cyclohexyltrichloroethyl radical is estimated to be $2.1 \times 10^4\ sec^{-1}$ at 150°C. (auth)

40740 KINETICS OF γ-RADIATION-INDUCED FREE-RADICAL CHAIN REACTIONS BETWEEN ALKANES AND CHLOROOLEFINS. I. SOLUTIONS OF TETRACHLOROETHYLENE IN ALKANES. Horowitz, A.; Rajbenbach, L. A. (Soreq Nuclear Research Center, Yavne, Israel). J. Amer. Chem. Soc., 91: 4626-31(Aug. 13, 1969).

The kinetics of γ-radiation-initiated free-radical chain condensation reactions in solutions of tetrachloroethylene in alkanes, RH (n-pentane, cyclopentane, and cyclohexane), resulting in the formation of alkyltrichloroethylenes, RC_2Cl_3, and HCl, were studied in the temperature range 26 to 150°C. The Arrhenius parameters for the addition of the alkyl radicals, R, to tetrachloroethylene were determined. In pentane the rate of formation of the condensation products is proportional to the first power of the solute concentration. In cyclohexane, and to a lesser extent in cyclopentane, some deviation from the first-order dependence of the products on tetrachloroethylene concentration is observed at room temperature. At 150°C this feature of the kinetics in cyclohexane disappears, presumably due to strong decrease in the steady-state concentration of the cyclohexyltetrachloroethyl radical. (auth)

40741 PHOTOCONDUCTIVITY OF γ IRRADIATED FROZEN ALKALINE SOLUTIONS. I. GENERAL TECHNIQUE, SPECTRAL RESPONSE OF THE EFFECT. Zagorski, Z. P.; Grodkowski, J.; Zimek, Z. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett., 1: 305-9(Aug. 25, 1969).

Aqueous alkaline solutions, γ-irradiated at 77°K show photoconductivity when illuminated at the same temperature. The spectral response of the effect coincides with the absorption spectrum of e_t^- in alkaline ice. (auth)

40742 RADIOCHEMICAL PREPARATION OF ^{61}Cu–COPPER SINGLE LINE SOURCE FOR THE MEASUREMENT OF THE MOESSBAUER EFFECT IN ^{61}Ni. Ambe, F.; Ambe, S.; Takeda, M.; Wei, H. H.; Ohki, K.; Saito, N. (Inst. of Physical and Chemical Research, Saitama, Japan). Radiochem. Radioanal. Lett., 1: 341-4(Aug. 25, 1969).

A radiochemical procedure is described to prepare a single line source of the short-lived ^{61}Cu for measurement of the Moessbauer effect in ^{61}Ni. The procedure is simple and up to 100 mCi of ^{61}Cu can be safely handled with the aid of simple radiation shields. (auth)

40743 THE EFFECT OF CHLORIDE IONS ON THE γ-RADIATION INDUCED DESTRUCTION OF NUCLEIC ACID BASIS IN AQUEOUS SOLUTION. Ward, J. F.; Kuo, I. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Int. J. Radiat. Biol., 15: 293-6(1969).

Irradiations of oxygen-saturated, aqueous solutions of cytosine and uracil were carried out at a dose-rate of ~7 krads/min. Hydrated electrons and $H^{\cdot}$ atoms were scavenged by molecular oxygen, leaving OH and Cl_2^- as the reactive species (assuming O_2^- and $HO_2^{\cdot}$ to be inactive in this system). Measurements of radioinduced base destruction were made as a function of pH and chloride ion concentration. A marked effect of chloride ions on G-(base) was noted. In the absence of chloride ions, G-(base) was almost independent of pH from 0.5 to 5 and equal to G(OH). In the presence of chloride ions, the yield of base destruction increased with decreasing pH, reaching a maximum and then decreasing. It was concluded that reactions of Cl_2^- with cytosine and uracil form radicals that can react with further pyrimidine molecules. For uracil this reaction proceeds via consumption of oxygen to produce a polyperoxide. (P.C.H.)

40744 THE FORMATION OF FREE RADICALS AND GAS RELEASE ON RADIOLYSIS OF STABILIZED POLY-ϵ-CAPROAMIDE. Fomenko, A. S.; Abramova, T. M.; Platonova, Z. P.; Furman, E. G. (Inst. of Physical Chemistry, Moscow). Vysokomol. Soedin., Ser. B, 11: 387-90(May 1969). (In Russian).

The formation of free radicals and the release of hydrogen and carbon oxides were studied in the radiolysis of poly-ϵ-caproamide, stabilized by additions of benzoic acid, secondary amines, hydroxy derivative of benzophenone, and certain sulfur-containing compounds. The additions of secondary amines decreased both the concentration of free radicals formed and the radiation yields of hydrogen and carbon oxides. Additions of benzoic acid and the hydroxy derivative of benzophenone had a stabilizing action on gas release. Premises are expressed concerning the mechanism of the protective action of these additions. (tr-auth)

40745 RADIATION POLYMERIZATION OF N-2,4-DIMETHYLPHENYLMALEIMIDE. Ivanov, V. S.; Smirnova, V. K.; Siborova, T. I. (Leningrad State Univ.). Vysokomol. Soedin., Ser. B, 11: 372-5(May 1969). (In Russian).

The polymerization of $\underline{N}$-2,4-dimethylphenylmaleimide ($\underline{N}$-2,4-xylylmaleimide) in the solid and liquid phases was carried out by ^{60}Co gamma radiation. In the solid phase, $\underline{N}$-2,4-dimethylphenylmaleimide is polymerized at a lower rate than any of the other $\underline{N}$-substituted maleimides. This is explained by the specific nature of the solid state of the monomer. Polymers of $\underline{N}$-2,4-dimethylphenylmaleimide are thermostable and possess increased solubility in organic solvents. (tr-auth)

40746 ADSORPTION OF OXYGEN ON SILVER DURING IRRADIATION OF SURFACES WITH SLOW ELECTRONS. Bailitis, Eduards (Kernforschungsanlage, Juelich, Ger.). Z. Phys. Chem. (Frankfurt), 64: 302-12(Apr. 1969). (In German).

A massive silver sample was irradiated at a temperature of −196°C with electrons at an energy of 1 eV to 10 keV. The irradiated silver surface proved to be an intensive oxygen adsorber. The gain was dependent on oxygen pressure and amounted to about 0.1 molecule/electron. (tr-auth)

40747 RADIATIVE NEUTRON CAPTURE ORGANIC YIELDS AS AN INDICATION OF THE STATE OF AGGREGATION OF ICl AND I_2 IN C_6–HYDROCARBON MATRICES AT 77°K. Lambrecht, R. M.; Hahn, H. K. J.; Rack, E. P. (Univ. of Nebraska, Lincoln). Contract AT(11-1)-1617. J. Phys. Chem., 73: 2779-82(Aug. 1969). (COO–1617-12).

The nuclear transformation technique was used to study clustering and segregation during crystallization of ICl and I_2 in polycrystalline n-hexane and 2,2-dimethylbutane, and glassy 3-methylpentane at 77°K. In the polycrystalline hydrocarbons, rather constant organic yields over appreciable concentration ranges suggest the formation of preferred $(X_2)_n$ cluster sizes and/or similar numbers of halogen molecules at sites in the hydrocarbon matrix. Similar clustering of halogens did not occur in glassy 3-methylpentane. (J.G.B.)

40748 RADIOLYSIS OF ETHANOL ADSORBED ON SILICA. Abrams, Lloyd; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 2741-5(Aug. 1969).

Ethanol on high-surface silica (Cabosil) is mainly held by physical adsorption, but a few per cent is held irreversibly in a form shown by infrared absorption studies to consist of $Si-O-C_2H_5$ and $Si-O-H$ groups. When the system was irradiated by γ rays considerable decomposition of ethanol resulted from transfer of excitation energy from the silica. The major gaseous products (hydrogen, carbon monoxide, and methane) occurred in about the same ratio as in radiolysis of liquid ethanol and probably resulted from excitation of adsorbed ethanol molecules, but small yields of ethane and ethylene varied in a peculiar manner which suggests that they arise from ethyl carbonium ions formed at acid sites created by radiation on the silica surface. (auth)

40749 THE γ-RAY RADIOLYSIS OF MONOSILANE AND MONOSILANE–ETHYLENE MIXTURES. Schmidt, J. F.; Lampe, F. W. (Pennsylvania State Univ., University Park). J. Phys. Chem., 73: 2706-12(Aug. 1969).

The γ radiolysis of pure monosilane at 300°K produced hydrogen and disilane with 100 eV yields of 17.0 and 5.3, respectively, and consumed monosilane with an estimated $G(-SiH_4)$ of 22. Considerable amounts of a brown polymeric substance were also observed. Ethylene partly inhibited the formation of hydrogen and disilane producing ethylsilane and diethylsilane in chain processes that are at least partially independent. The yields of all products in both the pure monosilane and in the mixtures with ethylene were affected by the surface-to-volume ratio. The most reasonable mechanism in accord with all observations is based on the conclusion that in pure monosilane, disilane and hydrogen are produced simultaneously in free-radical and ionic processes. In the monosilane–ethylene mixtures, ethylsilane appears to be formed exclusively by a free-radical reaction and diethylsilane by an ionic process. (auth)

40750 CHARGE SCAVENGING AND ENERGY TRANSFER IN γ RADIOLYSIS OF BENZENE SOLUTIONS. Hentz, Robert R.; Sherman, Warren V. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 73: 2676-80(Aug. 1969).

The γ radiolysis of benzene solutions of N_2O was studied over the concentration range 5 to 400m$\underline{M}$. Values of $G(N_2)$ are fitted with a published empirical equation for electron scavenging by N_2O in cyclohexane. The equation corresponds to a model which involves (1) electron capture by N_2O and (2) reaction of an anion produced via reaction 1 with another molecule of N_2O; both reactions compete with charge neutralization. Each occurrence of reaction 1 not followed by reaction 2 yields one molecule of N_2; each occurrence of reaction 1 followed by reaction 2 yields two molecules of N_2. Reaction 1 is characterized by a parameter α which is proportional to the specific rate (k_s) of the reaction and to an effective decay time (τ) for the distribution of geminate cation–electron separations produced in the solvent. For reaction 2, a parameter β is the analog of α. For G(geminate ions) = 3.9, best fit to the data was obtained for G(free ions) = 0, α in the range 0.65 to 0.75$\underline{M}^{-1}$, and corresponding values of β in the range 32 to 15$\underline{M}^{-1}$. Such a low value of α, as compared to $\alpha = 16\underline{M}^{-1}$ in cyclohexane, was interpreted in terms of an effect of solvent on k_s and τ. Suppression of $G(N_2)$ was observed with $c-C_4F_8$, CH_3Br, or trans-stilbene present in the $N_2O-C_6H_6$ solutions. In turn, N_2O suppressed the radioinduced isomerization of trans-stilbene in benzene; analysis of the effect by use of $\alpha = 0.70\underline{M}^{-1}$ gave an estimate of direct and ionic contributions to benzene excitation in γ radiolysis as G = 2.0 and G = 3.4, respectively. (auth)

40751 ELECTRON SPIN RESONANCE SPECTRA OF PEROXY RADICALS TRAPPED IN A γ-IRRADIATED SINGLE CRYSTAL OF TRIFLUOROACETAMIDE. Toriyama, Kazumi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Phys. Chem., 73: 2663-70(Aug. 1969).

It was found from the electron spin resonance spectra that the $\cdot CF_2CONH_2$ radical trapped in γ-irradiated trifluoroacetamide reacts with atmospheric oxygen to give the peroxy radical, $\cdot OOCF_2CONH_2$. The ESR spectra of the peroxy radicals showed a remarkable change with the observation temperature. The g tensors at 77 and 300°K were determined by analysis of the spectra of single crystals to be $g_1 = 2.002_2$, $g_2 = 2.007_4$, $g_3 = 2.038_4$ at 77°K and $g_1 = 2.021_0$, $g_2 = 2.018_2$, $g_3 = 2.008_2$ at 300°K. The decrease of the anisotropy of the g tensor at 300°K was well interpreted in terms of the partial averaging of the g tensor due to the internal rotation around the C–O bond. In addition, from the principal directions of the g tensors at both temperatures, the geometrical structure of the peroxy radical was approximately determined, by comparison with the principal direction of the hyperfine tensor of the α-fluorine atom of the $\cdot CF_2CONH_2$ radical trapped in the crystal together with the peroxy radicals. (auth)

40752 ON THE ORIGIN OF PRIMARY HYDROGEN PEROXIDE YIELD IN THE γ RADIOLYSIS OF WATER. Draganic, Z. D.; Draganic, I. G. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). J. Phys. Chem., 73: 2571-7(Aug. 1969).

In an attempt to throw light on the origin of $G_{H_2O_2}$, hydrogen peroxide yields were determined in deaerated aqueous solutions (pH 1.3 to 13) of different substances, irradiated with ^{60}Co γ-rays. Only those systems for which the reaction mechanism enables the direct measurement of $G_{H_2O_2}$ were chosen: 1-propanol, ethanol, acrylamide, acetone, and potassium nitrate. Particular care was taken to ensure that the values derived represent the initial yields. It was found that homogeneous kinetics can be used to express the dependence of $G_{H_2O_2}$ on hydroxyl radical scavenger concentration, and the origin of intraspur H_2O_2 in a pseudo-first-order process was considered. However, all experimental data obtained in this work demonstrate that $G_{H_2O_2}$ values depend on the reactivities as required in the diffusion kinetic model; the fractional lowering of primary peroxide yield decreases with increasing reactivity of the OH scavenger and increases with increasing e^-_{aq} scavenger reactivity. Previously published theoretical kinetic curves using the same parameters which furnish good agreement with LET effects, satisfy reasonably well the results presented here, hence the conclusion that the origin of $G_{H_2O_2}$ lies in the recombination of OH radicals within the spur. The experimental results also enable the determination of the primary hydrogen peroxide yields from the γ radiolysis of water: 0.76 ± 0.01 and 0.67 ± 0.01 at pH 1.3 and about 6, respectively. At pH 13 acrylamide solutions give $0.56 < G_{H_2O_2} < 0.67$ and other studies are desirable before a definite conclusion is made. (auth)

40753 RADIOLYSIS OF $HCOOH^+$ O_2 AT pH 1.3 TO 13 AND THE YIELDS OF PRIMARY PRODUCTS IN γ RADIOLYSIS OF WATER. Draganic, I. G.; Nenadovic, M. T.; Draganic, Z. D. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). J. Phys. Chem., 73: 2564-71(Aug. 1969).

The radiation yields of carbon dioxide, hydrogen peroxide, and hydrogen from oxygenated ($[O_2] = 1 \times 10^{-3}\underline{M}$) aqueous formic acid solutions were determined over the pH range 1.3 to 13. The formic acid concentration was varied between 1×10^{-4} and $5 \times 10^{-2}\underline{M}$ and the absorbed doses ranged from 3 to 16 krads. The radiation chemical behavior of solutes is discussed with particular attention to secondary reactions which may influence the measured initial yields of radiolytic products. Since these yields depend on solute reactivity they were corrected, before employing them to calculate the primary yields, using the Flanders–Fricke method and Kuppermann's diffusion-kinetic theoretical curves. The contribution of the reaction $HCOO^- + H$ to the measured yields of CO_2 and H_2 was also taken into account. From the results obtained, one can calculate at pH between 3 and 13: $G_{-H_2O} = 4.09$, $G_H + G_{e^-_{aq}} = 3.18$, $G_{OH} = 2.72$, $G_{H_2} = 0.45$, and $G_{H_2O_2} = 0.68$. The increase in acidity induces an increase in water decomposition. At pH 1.3 the following values were derived: $G_{-H_2O} = 4.36$, $G_H + G_{e^-_{aq}} = 3.49$, $G_{OH} = 2.85$, $G_{H_2} = 0.43$, and $G_{H_2O_2} = 0.76$. These figures are discussed in the light of some uncertainties in corrections applied to measured values, as well as in reactions of formate ion at pH 12 to 13. (auth)

40754 GAS-PHASE REACTIONS OF CYCLOHEXENE WITH HIGHLY ENERGETIC TRITIUM. Weeks, Robert W. Jr.; Garland, John K. (Univ. of Missouri, Columbia). J. Phys. Chem., 73: 2508-11(Aug. 1969).

The reactions of recoil tritium with cyclohexane were studied in the gas phase using noble gases as moderators. Both the ratio of cyclohexane/noble gas and total pressure of the system were used as experimental parameters. Products formed included HT, ethene-t̲, propene-t̲, 1,3-butadiene-t̲, 1- and/or 3-hexene-t̲, cyclohexane-t̲, methylcyclohexane-t̲, cyclohexene-t̲, and tritiated "polymers" (C_8 and up) of low and high molecular weights. Reaction pathways involving ionic or excited-state tritium were evidenced in the HT, methylcyclohexane-t̲, and polymer-t̲ yields which were higher in helium-moderated samples than in those that were xenon moderated. Species moderated to thermal or epithermal energies were found to be the primary moieties in the formation of cyclohexane-t̲ and polymer-t̲. (auth)

40755 RADIATION–CHEMICAL COPOLYMERIZATION OF STYRENE WITH VINYL CHLORIDE. II. PYROLYSIS OF STYRENE–VINYL CHLORIDE COPOLYMERS IN THE FIELD–ION MASS SPECTROMETER. Ryska, M.; Schueddemage, H.-D. R.; Hummel, D. O. (Univ., Cologne). Makromol. Chem., 126: 32-41(July 18, 1969). (In German).

Polystyrene, poly(vinyl chloride), mixtures of these polymers, and copolymers of styrene and vinyl chloride obtained under different conditions were pyrolyzed in a field-ionization mass spectrometer. While the pyrolysis of the mixtures led to fragments with the same mass number as obtained by pyrolysis of the homopolymers, the copolymers yielded additional fragments with values for mass number between 100 and 250. Phenylbutadiene (mass number 130) was formed from adjacent units of styrene and vinyl chloride. The intensity of the peak at mass 130 gave a measure for the block character of the copolymers. The results were compared with those obtained from kinetic and infrared investigations. Slow pyrolysis at low temperatures (350 to 400°C) showed that the thermal decomposition of the copolymers starts within the vinyl chloride sequences. (auth)

40756 RADIATION–CHEMICAL COPOLYMERIZATION OF STYRENE WITH VINYL CHLORIDE. I. INVESTIGATIONS ON THE MECHANISMS AND KINETICS OF THE REACTION. Ryska, M.; Schneider, Ch.; Hummel, D. O. (Univ., Cologne). Makromol. Chem., 126: 23-31(July 18, 1969). (In German).

Vinyl chloride and styrene were copolymerized with ^{60}Co γ rays in the temperature range from –78 to 50°C. The dependence of copolymer composition on temperature and composition of the monomer mixture was studied. The formal copolymerization parameters were determined and ir-studies were carried out to obtain qualitative information on the distribution of the monomer units in the copolymers formed under different conditions. From the results obtained, it was concluded that the copolymerization at temperatures from –78 to +20°C is partly due to a radical mechanism, partly to an ionic reaction. (auth)

40757 ROLE OF CATIONS IN RADIATION GRAFTING AND HOMOPOLYMERIZATION. Huglin, M. B.; Johnson, B. L. (Univ. of Salford, Eng.). J. Polym. Sci., Part A-1, 7: 1379-84 (June 1969).

The grafting of acrylic acid in aqueous solution to nylon 6 film was studied in the presence of ferrous, ferric, and cupric salts. The mutual irradiation technique was adopted using a ^{60}Co source. The anions were found to have no effect on the grafting or homopolymerization, but both of these processes were suppressed by the cations in the following order of effectiveness: $Cu^{2+} > Fe^{2+} > Fe^{3+}$. The rate constant for the capture of hydroxyl radicals by acrylic acid was determined as 6×10^9 l mole^{-1} sec^{-1} by pulse radiolysis using the CNS^- competition method. By invoking this result, mechanisms were suggested for the process of chain termination by metal cations. (auth)

40758 RECOIL REACTION PRODUCTS OF ^{11}C IN SIMPLE AROMATIC COMPOUNDS. Williams, Ronald L.; Voigt, Adolf F. (Ames Lab., Iowa). J. Phys. Chem., 73: 2538-44(Aug. 1969).

Carbon-11 was produced by the reaction $^{12}C(\gamma,n)^{11}C$ in liquid benzene, toluene, and p-xylene, and the labeled products were analyzed by radiogas chromatography. A wide variety of products from methane to phenylacetylene was observed accounting for 20 to 35% of the total ^{11}C activity in the various systems. The remainder of the activity is shown to reside in higher boiling compounds. The production of analogous products in these systems is discussed, and the effect of the methyl groups on the product distribution is evaluated. (auth)

40759 FURTHER EXPERIMENTS ON THE ISOMERIC EFFECT IN SZILARD-CHALMERS RECOIL OF ^{60m}Co AND ^{60g}Co IN Co(III) COMPLEXES. Lazzarini, E.; Rantola-Lazzarini, A. L. (Politecnico, Milan). J. Inorg. Nucl. Chem., 31: 1947-61(July 1969).

Previously it was found that ^{60m}Co and ^{60g}Co atoms behave differently following their Szilard-Chalmers recoil and that the effect, measured by means of the ratio ρ of the ^{60m}Co to ^{60g}Co retention, depends on the chemical constitution of the target. The value of the isomeric effect is correlated in Co(III) complexes with the splitting Δ of 3d-orbitals of Co(III), induced by the ligand field, and with the ability of ligands to promote back-donation from the Co(III) atom. A study was made on the dependence of ρ on the irradiation time T, the storage time t after the irradiation, and the storage temperature. The investigation was carried out on ten Co(III) complexes which do not present high back-donation. It was found that ρ depends on the above mentioned parameters, but the correlation between ρ and Δ is valid until a temperature of about 60°C is reached. At higher temperatures the correlation vanishes, although an isomeric effect is also evident at 135°C, it is no longer dependent on Δ. The results are discussed in terms of possible mechanisms leading to the isomeric effect. (auth) (UK)

40760 METHOD FOR PROMOTING CHEMICAL REACTIONS. (to Japan Atomic Energy Inst.). British Patent 1,160,405. Aug. 6, 1969. Priority date Aug. 3, 1966, Japan.

A method of promoting a chemical reaction by radiation comprises dissolving a radioactive gas, which is chemically inert in the liquid system, in the system under pressure that is sufficiently high to dissolve the gas in an amount sufficient to yield a radiation dose high enough to initiate the reaction. The preferred gases are ^{41}Ar, ^{85}Kr, or ^{133}Xe. A polymerization reaction that proceeds by way of a free-radical mechanism can be initiated by this method. (B.L.M.)

40761 ELECTRON SPIN RESONANCE STUDIES OF THE FORMATION OF ANION RADICALS ON γ-IRRADIATED SILICA GEL. Yamada, Yoshio; Hasegawa, Akinori; Miura, Masaji (Hiroshima Univ.). Bull. Chem. Soc. Jap., 42: 1836-40(July 1969).

The ESR spectra assigned to the anion radicals of SO_2^-, $(TCNE)^-$ (tetracyanoethylene), and O_2^- were obtained for sulfur dioxide, TCNE, and oxygen, respectively, when these gases were adsorbed on γ-irradiated silica gel. As regards sulfur dioxide, a characteristic change in the concentration of the SO_2^- radical was observed during the post-irradiation with high-energy uv light. In the case of carbon dioxide, the CO_2^- radical was produced only when uv post-irradiation was added to γ irradiation. The assignments were principally made in comparison with the reported g-values. Identification of the CO_2^- radical was ascertained by using ^{13}C. The analyses of the g-factor for the O_2^- radical and of ^{13}C hyperfine constants for the CO_2^- radical gave information on the interaction of the radicals on a solid surface with the cations in the adsorption center. In view of the fact that each of these molecules possesses a different degree of electron affinity, the results indicate that the electrons trapped in the defects of the silica gel surface transfer to the adsorbed molecules and that uv light promotes the electron transfer. (auth)

40762 THE YIELD OF HYDROGEN ATOMS IN THE VAPOR PHASE RADIOLYSIS OF AMMONIA. Nishikawa, Masaru; Kuroda, Kazufumi; Matsuura, Niro (Tokyo Univ.). Bull. Chem. Soc. Jap., 42: 1783-6(July 1969).

Gamma radiolysis of $NH_3 + C_3H_8$ mixtures was investigated at 22 ± 1°C and total pressure ~50 cm Hg. From the observed hydrogen yield, H atom yield in the radiolysis of ammonia G_H = 5.1—5.8 was obtained after subtraction of the contribution from the propane fraction. The value was significantly lower than that determined from the study of $NH_3 + D_2$ and $NH_3 + N_2H_4$ systems, and also that from the study of $NH_3 + C_3H_8$ system reported previously. A variety of possibilities is discussed with respect to the cause of the disagreement. The effects of addition of N_2O or SF_6, which acts as an electron scavenger, were also studied. The hydrogen yield from $NH_3 + C_3H_8$ mixtures decreased appreciably, and $\Delta G(H_2)$ in the absence and presence of electron scavengers was related to the change in the neutralization process. (auth)

40763 EFFECT OF PHASE ON THE TRAPPED RADICAL IN THE RADIOLYSIS OF SOLID ISOBUTANE AS STUDIED BY ESR SPECTROSCOPY. Miyazaki, Tetsuo; Wakayama, Terunobu; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap., 42: 2086(July 1969).

ESR spectral studies showed that quite different radicals are trapped in the radiolysis of isobutane depending on whether it is in the glassy or the crystalline state. The spectrum of the glassy state in a mixture was 3-methylpentane consisted of ten equally spaced lines with a coupling constant of 22.3 G. The spectrum coincided with the spectrum of t-C_4H_9 radicals produced by dissociative-electron attachment to t-C_4H_9Br in the radiolysis of 3-methylpentane containing 5 mole % t-C_4H_9Br at 77°K. (P.C.H.)

40764 γ-RADIOLYSIS OF AQUEOUS BORIC ACID SOLUTION. Suzuki, Shin (Chiba Univ., Japan); Koike, Mitsuru. Chiba Daigaku Kogakubu Kenkyu Hokoku, 19: No. 36, 173-81(Dec. 1968). (In Japanese).

Under the effects of γ radiation, increasing boric acid concentration increased H_2 formation to 10^{-7} mole/ml but did not noticeably increase O_2 or H_2O_2. Since boric acid reacts with the species formed by the primary process of water radiolysis at a relatively slow rate, when a good scavenger for e_{aq}^-, the precursor of H_2, such as NO_2^-, was present, boric acid had no effect on the total yield of H_2 at the concentration studied. However, the yields of other products of radiolysis, H_2O_2 or NO_2^-, were significantly diminished at high concentration of boric acid when NO_2^- was present. These results are explained by the established reaction schemes for radiolysis of aqueous solution. Furthermore, the yield curves for NO_2^- from nitrate solution were understood to suggest the reaction of NO_2^- with H_3BO_3 or H_2BO_3 radical, the plausible reaction product from the reaction, $H_3BO_3 + OH \rightarrow H_2O + H_2BO_3$. (NSA of Japan)

40765 PRODUCTION OF SULPHONIC ACIDS WITH ACTINIC RADIATION. Marrian, Stanley Frederic (to British Hydrocarbon Chemicals Ltd.). U. S. Patent 3,454,481. Priority date June 12, 1964, Great Britain.

A process for the production of alkane sulfonic acids comprises irradiating a paraffin, free from added peracid, with actinic radiation in the presence of SO_2, O, and between 0.01 and 10 wt %, based on the paraffin, of a monocarboxylic acid free from ethylenic unsaturation and having at least two carbon atoms in the molecule. (Offic. Gaz.)

40766 IONIZING RADIATION INDUCED ADDITION OF TRICHLOROSILANE TO ALLYL CHLORIDE. Stark, Forrest O.; Valicenti, John A.; Vogel, George E. (to Dow Corning Corp.). U. S. Patent 3,453,193. Filed Nov. 21, 1966.

A method is described for producing significantly improved yields of 3-chloropropyltrichlorosilane by mixing trichlorosilane and allyl chloride in specific mole ratios, heating within a particular temperature range, and subjecting the mixture to a regulated dosage of ionizing radiation. (Offic. Gaz.)

40767 ACTION OF HIGH ENERGY RADIATION ON INSULATORS. Belloc, P.; Fallou, B. Rev. Gen. Elec., 78: 50-2(Jan. 1969). (In French).

The action of ^{60}Co γ rays and 6-MeV electrons on various insulators, including polyethylene terephthalate, paper—polyamide, polyethylene, polyimide, epoxy resin, varnish, phenoplast paper, and enameled thread was studied. Doses ranged from 0 to 1000 MRAD, after which electric and mechanical characteristics were measured. These properties included rigidity, transverse resistivity, superficial specific resistance, tg d, lengthening, and charge to rupture. The polyimide and polyamide paper were found superior to the other insulators with respect to conservation of electrical and mechanical properties after irradiation, though the others could often be used where expected doses are less than those used for this study. Preliminary studies on plated copper for printed circuits suggested that the best results after irradiation were achieved for parallel bands separated by 4 mm (not 1 or 2 mm) and 5-outlet combs. (BBB)

40768 STUDIES IN EFFECT OF γ RADIATION ON SYNTHETIC FIBERS. I. Potnis, S. P.; Shetty, S. M.; Rao, K. N.; Prakash, Jai (Bhabha Atomic Research Center, Bombay). Angew. Makromol. Chem., 6: 127-35(Mar. 28, 1969).

Polyester and polyamide yarns were exposed to γ rays with varying doses of irradiation, both in vacuum and in the presence of air. All irradiations were done at Bhabha Atomic Research Center, Trombay, using the γ-220 cell, between 32 and 40°C. The dose rate was 1.1×10^6 RAD/hr/g. Varying doses from 1×10^5 to 5×10^7 RAD were used depending on the chemical structure of the polymer. The changes in such properties of the polymers as mp, relative viscosity, tensile strength, and dye absorption were investigated. Results indicate that though with higher doses there is degradation of the polymer, under controlled conditions certain desirable properties of the fiber are greatly improved without affecting the mechanical strength. Increase in mp and relative viscosity indicates the possibility of crosslinking of the chains. Increase in the breaking load observed in the initial stages appears to be due to the presence of crosslinking with the subsequent drop probably caused by the degradation of chains as shown by viscosity measurements. The percentage elongation was observed to increase up to 1×10^6 RAD suggesting that the irradiation causes loosening of the structure. The increase in the amount of disperse dyes adsorbed by the irradiated fiber was possibly due to the increased loosening of the structure to improve the dyeability of the fibers, which are difficult to dye with disperse dyes under usual conditions of dyeing. (BBB)

40769 γ RADIOLYSIS OF BENZENE AT HIGH TEMPERATURES AND PRESSURES. Burns, W. G.; Marsh, W. R. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 65: 1827-41(July 1969).

Benzene was irradiated at 260 to 390°C, and yields of hydrogen, methane, acetylene, ethylene, ethane, biphenyl, and conversion to polymer were measured as functions of dose, density, and temperature. No special effects were observed at or near the critical temperature. In general, all yields decreased smoothly with increasing density, and increased with increasing temperature. The most marked increase with temperature was in $G(H_2)$, which increased approximately thirty-fold (from ~0.1 to ~3) from 260 to

390°C. The only dimer found was biphenyl, whose yield was also strongly temperature dependent. The effects of density were attributed to the competition between deactivation and decomposition of excited molecules, and the effects of temperature to the competition between different reactions of hydrogen atoms, or cyclohexadienyl radicals. The competing hydrogen atom reactions considered were: $H\cdot + C_6H_6 \rightarrow C_6H_7\cdot$ and $H\cdot + C_6H_6 \rightarrow H_2 + C_6H_5\cdot$ but competing modes of decomposition of the cyclohexadienyl radical $C_6H_7\cdot \rightarrow C_6H_6 + H\cdot$ and $C_6H_7\cdot \rightarrow C_6H_5\cdot + H_2$ were adjudged a more probable cause of the variation of $G(H_2)$ with temperature. Methane, ethylene, and ethane appeared to be secondary products, and the long irradiations necessary to measure G(→polymer) thermal reactions, such as the polymerization of acetylene, and the hydrogenation of acetylene and ethylene, affected the observed yields. The effects of density and temperature on radiolytic yields were considered in relation to models which have been proposed to explain product formation in the radiolysis of aromatic liquids. (auth) (UK)

40770 ANNEALING REACTIONS IN POTASSIUM CHROMATE. PART 1. PROCESSES INVOLVING RECOIL ^{51}Cr(III) SPECIES. Ackerhalt, R. E.; Collins, C. H.; Collins, K. E. (State Univ. of New York, Buffalo). Trans. Faraday Soc., 65: 1927-35(July 1969).

Isothermal and isochronal annealing of neutron activated K_2CrO_4 was investigated by measuring the ^{51}Cr distribution among aqueous ^{51}Cr(VI), ^{51}Cr(III)-monomer, ^{51}Cr(III)-dimer, and ^{51}Cr(III)-polymer species following dissolution. Annealing occurring in the temperature range from −8 to 240° was tentatively associated with a set of reactions involving at least five crystal phase ^{51}Cr-containing species. Electrons, holes, or other irradiation produced species in the bulk crystal appeared to participate only in reactions occurring below 100°, where little annealing to ^{51}Cr(VI) occurred. The principal reaction in this range was a conversion of dimer-forming species to monomer-forming species. Below 180°, ^{51}Cr(III)-monomer-forming species did not produce appreciable ^{51}Cr(VI). Above 180°, part of the ^{51}Cr(III)-monomer-forming species was rapidly converted to ^{51}Cr(VI) while the remainder was converted to ^{51}Cr(VI) at the same relative rate as was the remaining ^{51}Cr(III)-dimer-forming species. (auth) (UK)

40771 DEGRADATION OF METHYLCELLULOSE BY IONIZING RADIATION. Chamberlin, T. A.; Kochanny, G. L. Jr. (Dow Chemical Co., Midland, Mich.). Macromolecules, 2: 88-93 (Jan.-Feb. 1969).

Degradation of methyl cellulose in the solid state induced by ^{60}Co γ radiation was studied in the presence and absence of H_2O and air. Kinetic treatment of the change in viscosity of 2% solutions, which is related graphically to the molecular weight was chosen as a means of study. Equations fitting the data are derived. A value for the exponent of intensity is determined as 0.7; values for the exponent of intensity in rate equations of the order of 0.5 are usually interpreted in terms of a biradical termination mechanism. The effects of O_2 and H_2O were studied. Pretreatment consisted of a prolonged evacuation at pressures of 3×10^{-6} mm. Similar treatment of the data demonstrated clearly that in the absence of these 2 additives, the reaction proceeded at a rate that was a function of the intensity to the first power. The theory of random chain fracture is applied to the results and consideration of the rate of formation of various species during the degradation, leads to conclusions regarding the mechanism of the degradation. The reaction behaves in a manner consistent with a short-chain, free-radical mechanism resulting in concurrent fragmentation and ester formation. (BBB)

40772 APPLICATION OF MASS SPECTRAL DATA TO THE RADIOLYSIS OF ALIPHATIC ALCOHOLS. PART I. METHANOL, ETHANOL, AND 1-PROPANOL. Basson, R. A. (Atomic Energy Board, Pretoria). J. S. Afr. Chem. Inst., 22: 63-79(Jan. 1969).

The mass spectra of 3 aliphatic alcohols were modified in an attempt to set up a fragmentation scheme for an excited molecular ion formed in an irradiated liquid. The assumption is made that the fragmentation pattern is only modified by collisional deactivation and that fast unimolecular reactions take place in the liquid phase in exactly the same manner as in a dilute vapor. Reaction schemes are proposed for the fragment ions that are assumed to react with the substrate by proton transfer, charge exchange, or hydride ion transfer. Free radical and stable product yields of these reactions were determined. Further reactions of the radicals are proposed and final stable product yields established. The calculated yields were compared with experimental radiolysis yields. Good agreement was obtained. The results indicated that the mass spectrum is a useful starting point for the prediction of radiation chemical yields in the liquid phase. The general success of the method offers evidence of the importance of ion-fragmentation and ion-molecule reactions in liquids and points to the importance of considering these possibilities when setting up a radiolysis mechanism. (BBB)

40773 ANTICOAGULANT SURFACES PRODUCED BY RADIATION GRAFTING HEPARIN TO A SILICONE SUBSTRATE. Bennett, Donald R.; Stark, Forrest O.; Vogel, George E. (to Dow Corning Corp.). U. S. Patent 3,453,194. Filed Aug. 3, 1966.

Exposing silicone surfaces to high-energy ionizing radiation and contacting the surfaces with heparin grafts the heparin to the silicone and renders the surfaces anticoagulative to blood. (Offic. Gaz.)

40774 METHOD FOR PRODUCING POLYVINYL CHLORIDE RESIN OF IMPROVED QUALITY. Sagane, Norio (to Sekisui Chemical Co.). Japanese Patent 1969-7353. Mar. 31, 1969. Filed July 3, 1965.

Polyvinyl chloride in the form of powder is brought in contact with gaseous 1,3-butadiene while one of these two, at least, is in movement. Then the system is irradiated with ionizing radiation at −5 to 90°C to the dose of 10^3 to 10^7 RAD in order to graft polymerize the gaseous 1,3-butadiene on the polyvinyl chloride at a grafting ratio of 8 to 30%. The ionizing radiation employed includes neutrons, electrons, α and β particles, and γ rays; the total dosage applied is determined by the desired grafting ratio. The PVC in general has wide uses because of its relatively low cost and its balanced properties. (NSA of Japan)

40775 METHOD FOR PRODUCING XENON COMPOUNDS AND FOR FIXING FISSION-PRODUCT OF XENON, WITH NEUTRON IRRADIATION. Kamemoto, Yuichiro (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-9727. May 7, 1969. Filed Mar. 16, 1965.

A method is proposed for producing a compound, viz. the fluoride of xenon, or fixing fission-product xenon, by neutron irradiation of a mixture of uranium compound and fluorides. The uranium compound, such as UO_2 and the fluorides of Li, Na, K, etc., are first neutron-irradiated by a suitable means. The irradiated mixture is placed at the bottom of a glass tube and the tube is evacuated. The mixture is heated in a furnace, so as to give a temperature gradient along the tube length. Fission-product xenon and its compound are evolved from the mixture; the compound deposits on the tube wall, while the xenon gas remains in the tube space. Then the tube is cooled; and the gas is removed. The portion of tube containing the deposited xenon compound is sealed at both ends. (NSA of Japan)

40776 METHOD FOR PRODUCING 1-SUBSTITUTION CHLORINE-CONTAINING ALKYL ALICYCLIC ALCOHOLS. Yumoto, Takaatsu (to Industrial Science and Tech. Agency). Japanese Patent 1969-9663. May 6, 1969. Filed Mar. 26, 1966.

A radioinduced reaction between chlorinated ethylene and an alicyclic alcohol produces a high yield of 1-chlorine-containing alkyl alicyclic alcohols. One mole of cyclohexanol is mixed with 0.01 to 100 moles of tetrachloroethylene, trichloroethylene, or cis- or trans-dichloroethylene, and the mixture is subjected to γ irradiation under a controlled atmosphere. The reaction proceeds at ordinary temperatures, but the reaction time decreases with increasing temperature. The yield of the product increases at high radiation dose rates. (NSA of Japan)

40777 METHOD FOR PRODUCING POLYOXYMETHYLENE WITH HIGH MOLECULAR-WEIGHT. Ishida, Shinichi (to Asahi Chemical Industry Co.). Japanese Patent 1969-11389. May 26, 1969. Filed Dec. 31, 1964.

A method is proposed for producing heat-resisting polyoxymethylene with high molecular weight without an additional purifying process. The product is capable of taking any desired forms, e.g., film, sheet, fiber, etc. Low molecular-weight polyoxymethylene is irradiated with either ionizing radiation or uv rays, to denature it. Then, the denatured polyoxymethylene is pyrolyzed, to obtain formaldehyde, which is polymerized by conventional methods. For the irradiation, ionizing radiation may be α, β, or γ rays, or x-rays; the use of a Van de Graaff machine or ^{60}Co source is both easy and convenient. The irradiation may be done in the air, vacuum, or inert gas atmosphere. (NSA of Japan)

40778 METHOD FOR PRODUCING GRAFT-COPOLYMERS. Shimoi, Masayoshi (to Toyo Rayon Co.). Japanese Patent 1969-7343. Mar. 31, 1969. Filed May 11, 1966.

The proposed method for producing graft copolymers has the following advantages: reduction in the amount of irradiation, low temperature in graft copolymerization, short period of graft copolymerization, and high grafting ratio. The organic polymer to be graft-copolymerized, in which a salt of an inorganic acid with an organic amine is introduced or adsorbed, is irradiated with ionizing radiation, in air or in the presence of oxygen. And then, it is brought in contact with a monomer capable of radical polymerization. Alternatively, the organic polymer is irradiated with ionizing radiation, either in air or oxygen. Then, it is brought in contact with a monomer capable of radical polymerization, in the presence of a salt of an inorganic acid with an organic amine. The organic polymers are polyethylene, cellulose, etc.; the monomers are acrylonitrile, styrene, etc.; the ionizing radiations may be β particles, γ radiation, or accelerated electrons. (NSA of Japan)

40779 METHOD FOR PRODUCING THE POLYMER OF ETHYLENE TETRAFLUORIDE. Fujioka, Shuji (to Toyo Rayon Co.). Japanese Patent 1969-7352. Mar. 31, 1969. Filed Aug. 6, 1965.

Ethylene tetrafluoride was dissolved in an aliphatic or an alicyclic compound in which all the hydrogen in the saturated hydrocarbon was substituted by either fluorine or chlorine. And the solution was irradiated with ionizing radiation, to obtain the ethylene tetrafluoride polymer. The mixing ratio of the monomer and solvent may be 1 mole of the monomer to 0.3 to 8.0 moles of the solvent; the irradiation temperature, −20 to 70°C; the irradiation time, adjusted for the polymerization to be 5 to 30%; and the radiation dose, 1.0×10^3 to 5×10^5 RAD/hr. (NSA of Japan)

40780 METHOD FOR IMPROVING THE QUALITY OF VINYL-CHLORIDE RESINS. Suzuki, Fumio (to Sumitomo Electric Industries Ltd.). Japanese Patent 1969-8739. Apr. 23, 1969. Filed July 27, 1965.

The quality of vinyl chloride resins was improved by introducing a bridging in the system of polyvinyl−epoxy compound by irradiation of the two components mixed with an accelerator, e.g., an organic or inorganic chlorine. The advantages of this process are: the reduction in the amount of irradiation for the bridging, low cost, and superior properties of the product, including heat-resistance, solvent-resistance, and mechanical and electrical properties. (NSA of Japan)

40781 DEVELOPMENT OF ELECTRON CURING PAINTS: THE CHARACTERISTICS OF NISSAN BEAM COAT. Masuda, Hiromasa (Nippon Oils and Fats Co., Tokyo). Genshiryoku Kogyo, 15: No. 2, 58-60(Feb. 1969). (In Japanese).

The development of electron curing of paints in America, England, and Japan is reviewed. The "Nissan Beam Coat" was described for the following uses: as paints for an electron beam furnace; woodworking uses; metalworking uses, such as color-coatings and paints for Al materials; and uses for textiles, papers, leathers and plastic films. The characteristics of "Nissan Beam Coat" are rapid drying within a few minutes, curability at ordinary temperatures, and no need for the considerations about the pot-life of polymer paints and the catalyst for curing. The utilization of β radiation as the active source is a future possibility, and the uses of electron curing paints could increase rapidly by the development of a stable and efficient electron accelerator. (NSA of Japan)

40782 COMMENTS ON THE CAUSE OF EXPLOSIONS IN REACTOR CRYOSTATS FOR LIQUID NITROGEN. Schuftan, P. M. (British Oxygen Co. Ltd., Brentford, Eng.). Cryogenics, 9: 290(Aug. 1969).

It was previously reported that irradiated high purity oxygen-free nitrogen containing NO or NO_2 gave no explosion after the addition of acrylonitrile; however, irradiated liquid nitrogen containing oxygen did. It is suggested that while O_3 formation may be the cause, the formation of a reactive nitrogen oxide is more likely to be responsible. (UK)

40783 RADIATION METHOD OF OBTAINING OF WOOD-PLASTIC MATERIALS. Glukhov, V. I.; Zaivii, V. A.; Shiryaeva, G. V.; Karpov, V. L. Plast. Massy, No. 7, 12-13(1969). (In Russian).

Kinetics of the γ-radioinduced polymerization of methyl methacrylate and styrene in wood was investigated. It was found that an increase in polymer content improves the stability properties of wood. The use of integral doses of irradiation above 5 Mrad results in the deterioration of the stability properties of the product. (tr-auth)

40784 ROLE OF THE SURFACE OF SILICA GEL IN THE RADIOCHEMICAL TRANSFORMATIONS OF ADSORBED HYDROCARBONS. Suprunenko, K. A.; Strelko, V. V.; Kabakchi, A. M. Teor. Eksp. Khim., 5: 353-60(May-June 1969). (In Russian).

The effects of γ radiation on benzene−silica gel and hexane-silica gel at various component ratios were studied by electron paramagnetic resonance. It was found that hydrogen atoms, which break away from the surface OH-groups during irradiation, react with adsorbed hydrocarbons, producing the radicals, $C_6H_7^{\cdot}$ (in the case of deuterated silica gel, $C_6H_6D^{\cdot}$) and $C_6H_{13}^{\cdot}$. It was established that $\equiv SiO^{\cdot}$ radicals formed during the irradiation also interact with the adsorbate. The participation of hydrogen atoms and $\equiv SiO^{\cdot}$ radicals in the radiochemical transformations of adsorbed hydrocarbons was confirmed by experiments with silica gels, previously dehydrated at various temperatures. Possible mechanisms of energy migration in silica globules were examined. (tr-auth)

Radiochemistry

Refer to abstracts 40677 and 42382.

Separation Processes

Refer also to abstracts 40601, 40602, 40610, 40616, 40659, 40861, 40887, 40927, 40969, 40979, 41067, 41609, 41702, 41713, and 43130.

40785 (AEC-tr-7076) SEMIANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY NO. 5, DECEMBER 1967–MAY 1968. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from pp 51-69; 155-242; 269-89; 307-30of report CEA-N-1044. 155p. Dep. CFSTI.

Five sections are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 40786–40790.

40786 (AEC-tr-7076, pp 1-19) TREATMENT OF MEDIUM-AND LOW-LEVEL EFFLUENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from pp 51-68 of report CEA-N-1044.

Studies were made on the treatment of medium- and low-level effluents by ion exchange, precipitation, evaporation, and the use of bacteria. Ion exchange lines and operation of the Saclay Pilot Resin Plant are discussed. Precipitation methods were developed for nitric or sulfuric acid effluents of high magnesium concentration. A simplified treatment using only precipitation of Sr by barium sulfate was developed for use in the case of a mixture of nitric and sulfuric acid effluents with other effluents from an irradiated fuel reprocessing center. An industrial prototype pulsed-air evaporation cell is described for the treatment of liquid effluents. Data on the results of the treatment of radioactive effluent by ozone are tabulated. (P.C.H.)

40787 (AEC-tr-7076, pp 20-72) STUDY OF AQUEOUS REPROCESSING METHODS: LABORATORY. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from pp 155-208 of report CEA-N-1044.

Methods are discussed for reprocessing natural U, PuO_2-UO_2, Al−U, and Al−Pu fuels, and thorium dissolution liquors containing U. Studies were made on the effects of tin on the reprocessing of Mosnal fuel, and the oxidation−reduction of plutonium during the reprocessing of Pu−U fuels. Hydrofluoric acid was found to suppress secondary zirconium reactions during the reprocessing of PuO_2-UO_2 fuels. Hydrofluoric acid can be considered for use in irradiated fuel reprocessing plants provided the corrosion problems are solved. Conditions and equipment for the dissolution of Al−U alloys were established. Data are given on the distribution of Pu in HNO_3−TBP−diluent. Studies were also made on the effects of diluent on the solvent extraction of Pu from waste solutions using tridodecylamine. A comparison was made of schemes for the separation of uranium from Th dissolution liquors by solvent extraction using dodecane−TBP. (P.C.H.)

40788 (AEC-tr-7076, pp 73-107) STUDY OF AQUEOUS REPROCESSING: PILOT PLANT. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from pp 209-42 of report CEA-N-1044.

Results are reported for studies on: adaptation of a pilot plant for reprocessing of enriched U−Al, U−Zr, and Pu−Al fuels; inactive operating tests on a pulsed column for reprocessing U−Al alloys; reprocessing of irradiated Th by dissolution and solvent extraction; on-line control of Th concentration by γ-absorption analyzer; and analytical control of irradiated Th reprocessing run. (P.C.H.)

40789 (AEC-tr-7076, pp 108-29) PREPARATION AND STUDY OF ACTINIDE BY ELEMENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from pp 269-89 of report CEA-N-1044.

Studies were made on the separation of Np from irradiated fuels by solvent extraction using TBP−dodecane−nitric acid. Special attention was given to the behavior of HNO_2 in counter-current extractions with TBP. Anion exchange was investigated for final purification of Np. The method developed was then tested on irradiated Np pins. (P.C.H.)

40790 (AEC-tr-7076, pp 130-55) STUDY OF THE VITRIFICATION OF FISSION PRODUCT SOLUTIONS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from pp 307-30 of report CEA-N-1044.

Descriptions are given of tests performed at Fontenay on the vitrification of fission product solutions obtained from reprocessing of low-alloyed uranium fuels. These tests included: vitrification with a double charge; effects of chemical composition on the solutions; tests on draining and fusing granulates from the Ru trap; development of a detection system for plugging the feed pipe; and intentional rupture of the Inconel pot to verify the behavior of the protective muffle. (P.C.H.)

40791 (ANL-Trans-751) STUDY OF VOLATILITY PROCESSING METHODS. Semiannual Report of the Department of Chemistry (No. 5). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translation of Chapter 9, pp 244-68 of report CEA-N-1044. 28p. Dep. CFSTI.

Methods for the volatilization of Al−U, U−Zr, and PuO_2-UO_2 fuels are described. Special attention was given to the kinetics of UO_2 fluorination by BrF_5 and NpF_4 by F. The results of thermal decladding tests on reactor fuel elements are also reported. (P.C.H.)

40792 (BM-RI-7288) CHEMICAL STABILIZATION OF THE URANIUM TAILINGS AT TUBA CITY, ARIZ. Havens, Richard; Dean, Karl C. (Bureau of Mines, Salt Lake City, Utah. Salt Lake City Metallurgy Research Center). Aug. 1969. 12p.

Acidic and basic uranium leach plant residues located on the Navajo Indian Reservation, Tuba City, Ariz., were successfully stabilized against wind erosion using a relatively low-cost chemical method. An elastomeric polymer chemical was applied to the dike areas and a calcium magnesium lignosulfonate to the beach areas of three tailings ponds. The water-soluble chemicals were applied with an automated sprinkling system. The stabilization cost was $335 per acre for the 34.5-acre tract. (auth)

40793 (BNWL-1072) THE USE OF ALTERNATING DTPA AND NTA CATION-EXCHANGE FLOWSHEETS FOR THE SIMULTANEOUS RECOVERY AND PURIFICATION OF Pm, Am, AND Cm. Wheelwright, E. J.; Roberts, F. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 43p. Dep. CFSTI.

In the two-step cation-exchange separation process for purification of Cm, Am, and Pm, a change in the elution sequence of Am, resulting from the alternate use of two different eluting agents, is utilized to greatly enhance the Am−Cm purification efficiency. Unlike the many-cycle separation process previously used to purify americium and curium, this flowsheet does not require high concentrations of chloride and is, therefore, completely compatible with conventional stainless steel equipment. The process was successfully demonstrated on a kilogram scale and the results are reported. (auth)

40794 (BNWL-1109) CARBON BED TREATMENT OF AQUEOUS PLANT WASTE FOR REMOVAL OF ORGANIC MATERIALS. Lerch, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 23p. Dep. CFSTI.

A bed of activated carbon was shown to quantitatively remove CCl_4, TBP, DBBP, DEHP, and TOPO from high salt aqueous waste concentrate solutions. The TBP-carbon bed or the DBBP-carbon bed would in turn "extract" plutonium from the aqueous waste solution. Recovery of the extracted plutonium and/or regeneration of the carbon bed are probably not economically feasible. (auth)

40795 (BNWL-tr-35) STUDY OF THE USE OF U(IV) IN THE SECOND URANIUM CYCLE OF THE EUROCHEMIC PLANT. Salomon, L.; Lopez-Menchero, E.; Ilardi, S.; Lopez de Manterola, E. ([European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)]). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report NP-17740. 21p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 11603. (auth)

40796 (BNWL-tr-36) STUDY OF URANIUM NITRATE AS A REDUCING AGENT FOR PLUTONIUM. V. MIXER-SETTLER TESTS FOR SEPARATING U−Pu. SEPARATION SCHEME WITH U(IV) AS REDUCING AGENT. Lopez-Menchero, E.; Salomon, L.; Ilardi, S. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report ETR-185. 56p. Dep. CFSTI.

The use of U(IV) in a Purex cycle for U−Pu separation was tested using a battery of mini-mixer-settlers with 16 stages, which represent in series the 1BX and 1BS columns. Under the conditions of the mixer-settler battery used, and in the presence of a large excess of U(IV) (stoichiometric excess near 10), the two parameters with the greatest influence on reduction yield are: the ratios of the aqueous and organic phases and the acidity of the "head-end" aqueous phase. (M.C.G.)

40797 (CEA-N-1044) SEMIANNUAL REPORT OF THE DEPARTMENT OF CHEMISTRY NO. 5, DECEMBER 1967–MAY 1968. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1968. 390p. (In French). Dep.

Twelve sections are included; separate abstracts were prepared for 6. Part of one section on preparation and study of actinide elements is included in AEC-tr-7076. The remaining part of the section was also abstracted from the present report. Four other sections are also included in AEC-tr-7076 and one section is included in ANL-Trans-751. (P.C.H.)

For abstracts of individual sections see: 40535, 40609, 40610, 40798, 40799–40800, and 41538.

40798 (CEA-N-1044, pp 69-80) TREATMENT OF URANIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Methods are described for the production of U and U_3O_8 by transformation of UF_6. The metal is produced by UF_6 reduction by hydrogen or sodium. The production of U_3O_8 involves the precipitation of uranyl formate from uranyl nitrate solutions by formic acid. Equipment designed for the production of U_3O_8 is described. (P.C.H.)

40799 (CEA-N-1044, pp 138-50) VARIOUS CHEMICAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Studies on the decalcification of seawater by dialysis, the desalination of seawater by electrodialysis, and the corrosion of various stainless steels, brass, Al−Cu, and Al−Ni by aerated NaCl solutions and synthetic seawater at 150°C are reported. (P.C.H.)

40800 (CEA-N-1044, pp 290-306) PRODUCTION OF ISOTOPES OF ACTINIDE ELEMENTS. TREATMENT OF IRRADIATED PLUTONIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

A method is described for the separation of transplutonium elements from rare earths, fission products, and Al in HNO_3 solutions by solvent extraction using D2EHPA in dodecane. The separation of Am and Cu proceeding from the second cycle of the actinide–lanthanide separation by ion exchange is given. The separation of Am from Cu by solvent extraction using tridodecylamine in the presence of HNO_3, $LiNO_3$, and DTPA by a manual countercurrent method is also described. (P.C.H.)

40801 (CEA-R-3821) DECONTAMINATION OF IRRADIATED-FUEL PROCESSING WASTE USING MANGANESE DIOXIDE HYDRATE. Auchapt, Jacqueline-Marguerite; Gaudier, Jean-Francois (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). June 1969. 33p. (In French). Dep. CFSTI (U. S. Sales Only).

The manganese dioxide process is designed to replace the "calcium carbonate" treatment for low and medium activity wastes. The objective was diminution of the volume of the sludge without decreasing the decontamination factor of the wastes. The process involves two additions of over 100 ppM of Mn^{2+} to waste previously made basic and oxidizing; the precipitate formed in situ is separated after each addition. The process has the advantage of increasing the decontamination of strontium. The treatment can be used in a plant including two decantation units and has given effective results when applied in such a plant. (auth)

40802 (CEA-R-3826) FIXATION OF METALLIC SULFOSALICYLATE COMPLEXES ON AN ANIONIC EXCHANGE RESIN. Cahuzac, Suzanne (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1969. 196p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

Since sulfosalicylate ions have acid-base properties, sulfosalicylate complexes have an apparent stability which varies with the pH. As a result, the fixation of sulfosalicylates on an anion exchange resin depends on the pH of the solution in equilibrium with the resin. Studies were made on the influence of the pH on the fixation of sulfosalicylate anions and of metallic sulfosalicylate complexes on an anion exchange resin (Dowex 1 × 4). In the first part frontal analysis was used to determine the distribution of sulfosalicylate ions in the resin according to the total sulfosalicylate concentration in the aqueous solution in equilibrium with the resin.

The exchange constants of these ions between the resin and the solution have been calculated. In the second part, a study has been made of the fixation of anionic sulfosalicylate complexes of Fe(III), Al(III), Cr(III), Cu(III), Ni(II), Co(II), Zn(II), Mn(II), Cd(II), Fe(II), and UO_2^{2+}. By measuring the partition coefficients of these different elements between the resin and the solution it has been possible to give interpretation for the modes of fixation of the metallic ions, and to calculate their exchange constant between the resin and the solution. The relationship has been established for each metallic element studied, between its partition coefficient, the pH and the total concentration of the complexant in solution. Such a relationship makes it possible to predict, for given conditions, the nature of the species in solution and in the resin, as well as the partition coefficient of a metallic element. Finally, use has been made of results obtained previously, to carry out some separations ($Ni^{2+}-Co^{2+}$; $Ni^{2+}-Co^{2+}-Cu^{2+}$; $UO_2^{2+}-Fe^{3+}$; $UO_2^{2+}-Cr^{3+}$; $UO_2^{2+}-Cu^{2+}$; $UO_2^{2+}-Ni^{2+}$; $UO_2^{2+}-Co^{2+}$; $UO_2^{2+}-Mn^{2+}$; and $UO_2^{2+}-Cd^{2+}$), as well as the purification of a uranyl sulfosalicylate solution. (auth)

40803 (DOCKET-50201-15) WEST VALLEY REPROCESSING PLANT. Quarterly Report, April 1–June 30, 1969. (Nuclear Fuel Services, Inc., West Valley, N. Y.). July 25, 1969. 15p. Dep. CFSTI.

The processing of NPR Lot XII was completed and processing of fuel from Cores V and VI of the Yankee reactor begun. The disposition of nuclear material in fuel at the plant is indicated. Waste processing and burial, environmental monitoring, and facility performance and modification are discussed. (M.C.G.)

40804 (KFK-901) SAFEGUARD EXERCISE AT THE FABRICATION PLANT ALKEM. Gmelin, W.; Nentwich, D.; Otto, H. E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb. 1969. 90p. (In German). Dep.

The results of the exercise showed the possibility of safeguarding a batch campaign exclusively at strategic points in an existing plant. The special measures performed were only necessary because of the specific layout of the ALKEM plant, in the future these measures will be redundant. The material balance could be established with fairly small measuring accuracies; hence, the diversion of a small quantity could be detected with a high probability, i.e., about 80% of the material withdrawn could be stated as having been diverted with a probability of 95%. The state of development of the instruments used can be regarded as being fairly sufficient for relatively small plants, but only sufficient as to their accuracies. As to the tamper-resistance the different activities in the framework of the SpFK project for the development of the instrumentation are absolutely necessary. From the results, the relative importance, the priorities for these developments could be obtained, i.e., the highest priority has to be given to the calorimetry. A surprising result was the fact, that the analysis of the waste stream could be established to a satisfactory degree with a mean accuracy of 8%. So that a high priority for the improvement of the accuracy of this stream will not be necessary. (P.C.H.)

40805 (ORNL-TM-2578) PROCESSING OF THE MSRE FLUSH AND FUEL SALTS. Lindauer, R. B. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 75p. Dep. CFSTI.

The MSRE Fuel Processing Plant, shakedown tests of equipment and procedures, and the uranium recovery operation are described. The MSRE flush and fuel salt batches were fluorinated to recover 6.5 and 216 kg of uranium, respectively. Known losses during processing were less than 0.1%. Gross beta and gamma decontamination factors of 1.2×10^9 and 8.6×10^8 were obtained. Corrosion averaged about 0.1 mil/hr. The corrosion product fluorides were reduced and filtered to provide a carrier salt having a lower concentration of metallic contaminants than the original carrier salt. (auth)

40806 (ORNL-tr-1927) SEPARATION OF ACTINIDES BY HIGH-VOLTAGE ELECTROPHORESIS. Baechmann, K. Translated by Martha Gerrard and K. S. Warren (Oak Ridge National Lab., Tenn.), from Radiochim. Acta, 6: No. 2, 62-4(1966). 5p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 4474.

40807 SALTING OUT AT EXTRACTION OF ACIDS AND SOME RADIOACTIVE ELEMENTS. PART III. EXTRACTION OF HNO_3 AND $HClO_4$ FROM THEIR MIXTURES WITH H_2SO_4 BY TBP. Frolov, Yu. G.; Nasonova, G. I. At. Energ. (USSR), 26: 546-8(June 1969). (In Russian).

An attempt was made to determine the salting-out ability of sulfuric acid and the possibility of using Mikulin's equation for calculating the coefficients of HNO_3, $HClO_4$, and H_2SO_4 activity in their mixtures. (R.V.J.)

40808 SEPARATION OF RARE EARTH ELEMENTS BY DISTRIBUTIVE CHROMATOGRAPHY WITH UTILIZATION OF BIS(2-ETHYLHEXYL) ORTHOPHOSPHATE SORBED ON SILICA GEL. Mikhailichenko, A. I.; Pimenova, R. M. Zh. Prikl. Khim., 42: 1010-16(May 1969). (In Russian).

Possibilities of the isolation of macroquantities of individual rare earth elements from their mixtures, in particular Y, Tb, and Yb, by distributive chromatography using DEHPA as the stationary phase were investigated. The effects of various parameters of the process were studied. (M.C.G.)

40809 EXTRACTION OF URANIUM BY TETRAPHENYLARSONIUM CHLORIDE (TPAC). Katsura, Kosho (Univ. of the Ryukyus, Okinawa). Bunseki Kagaku, 18: 844-9(July 1969). (In Japanese).

Uranyl ion was first combined with benzoic acid to make its anionic complex (uranyl tribenzoate) and then TPAC was added as an ion-associating reagent. In the range of pH 3 to 5, the uranyl tribenzoate reacts quantitatively with TPAC and forms a white precipitate in the ratio of 1 : 1, which is extractable into chloroform. The log – log plot of distribution ratio vs pH clarified that uranyl ion was coordinated with three benzoate ions. The effects of diverse ions on this extraction were also examined. WO_4^{2-} hindered seriously the extraction and must be absent. As much as 99% of uranium could be extracted into chloroform at the optimum pH in the absence of diverse ions. (auth)

40810 METHOD OF SEPARATING YTTRIUM FROM RARE EARTHS BY ION EXCHANGE. Morton, John R. (to Michigan Chemical Corp.). U. S. Patent 3,455,646. July 15, 1969. Filed Sept. 26, 1966.

A process is described for the separation of yttrium from mixtures of yttrium and rare earth metals by eluting the ions through the hydrogen form of a cation exchange resin with aqueous solutions of hydroxyethylethylenediaminetriacetic acid (HEDTA). The resin and eluting solution are maintained at temperatures in the range of about 32 to 95°C. Under these conditions Y ions elute substantially in advance of Nd with the exact eluting position depending on the temperature selected. High purity Y is produced the process. (Offic. Gaz.)

40811 FUELS FOR NUCLEAR REACTORS. PART II. THE CHEMICAL PROCESSING OF CONSUMED NUCLEAR FUELS. Koch, Guenter. Chem. Unserer Zeit, 2: 179-85(Dec. 1968). (In German).

The principles of chemical reclamation of spent fuel elements are briefly described, and a few general types named. Locations of important reclamation plants for recovery of U and Pu are tabulated. Procedures for hulling and dissolving the fuel in HNO_3 are explained, and details of the Purex process, including separation from fission products and separation of Pu as Pu(III) from higher oxidation states of U, are noted. Problems of instability of the organic phase under heavy radionuclide irradiation are noted. End purification processes, chromatographic procedures on adsorbent or ion-exchange columns, are described. The purification of Th is considered still in an experimental stage. Treatment and storage of highly active decay products are described in terms of conversion to glasses and storage in abandoned mines. Further uses for fission products are foreseen. (BBB)

40812 METHOD OF FLUORINATION OF NUCLEAR FUEL. (to Centre d'Etude de l'Energie Nucleaire). British Patent 1,158,287. July 16, 1969. Priority date Nov. 26, 1965, Luxembourg.

A process for the fluorination of a nuclear fuel comprises subjecting the fuel to the action of a gaseous mixture of F_2 and a compound containing fluorine and another halogen at a temperature between the boiling point of the compound and 500°C. The mixture should contain not more than 96 vol % F_2 and preferably between 5 and 50 vol % F_2. The compound of fluorine is a halogen polyfluoride, preferably ClF_3. (B.L.M.)

40813 METHOD OF SEPARATING NEPTUNIUM AND URANIUM VALUES. Katz, S.; Cathers, G. I. (to United States Atomic Energy Commission). U. S. Patent 3,451,790. Apr. 24, 1969.

A method of separating Np values from a gaseous mixture of NpF_6 and UF_6 comprises: contacting the gaseous mixture with NaF maintained at a temperature of 100 to 250°C to absorb both hexafluorides, selectively reducing the oxidation state of the adsorbed Np to a value less than 6 desorbing UF_6 from the NaF, and desorbing substantially uranium-free Np values from the resulting NaF. (AEC)

40814 SEPARATION OF RUTHENIUM AND PLUTONIUM BY A LITHIUM FLUORIDE SORPTION TECHNIQUE. Riha, James G.; Trevorrow, LaVerne E.; Steindler, Martin J. (to

United States Atomic Energy Commission). U. S. Patent 3,458,291. July 29, 1969.

A process for the separation of ruthenium fluoride from plutonium hexafluoride consists of flowing a mixture of the fluorides and fluorine gas through a bed of lithium fluoride particles maintained at about 400°C. The ruthenium fluoride forms a stable complex with the lithium fluoride while the plutonium desorbs in the form of plutonium hexafluoride. (AEC)

40815 EXTRACTION OF URANIUM. Spilliaert, P. Chim. Ind., Genie Chim., 101: 298-304(Feb. 1969). (In French).

The chemical attack of low-grade ores, containing U at levels of 0.1 to 0.2%, produces extremely dilute solutions containing less than 1 g/l of U. Methods for selective extraction and concentration of U from these solutions are reviewed. The principal means, ion exchange and liquid extraction, are reviewed from the viewpoint of chemistry, being classified as acid, basic, or solvating extractants. A description of some of the practical problems encountered in industrial applications of these techniques is given; ion exchange resin degradation, final adjustment of amine extraction plants, and the influence of structure of the amine on the purity of the U concentrate are noted. Problems arising from counterions in processes based on liquid extraction are outlined. These are discussed in terms of synergism, and a few practical solutions to the problems are given. (BBB)

40816 SOME EXAMPLES OF APPLICATIONS OF ION EXCHANGERS IN THE URANIUM INDUSTRY. Boutonnet, G. Chim. Ind., Genie Chim., 101: 305-17(Feb. 1969). (In French).

A historical background for current problems in ion-exchange technology in the U industry is given. Of particular interest are studies toward an operating mode of the semicontinuous type: these include elution with H_2SO_4 instead of HCl, treatment of the sulfate eluate with amines (in particular triisooctylamine, which also extracts traces of Fe, Cl, and non-negligible amounts of PO_4^{3-}, which can be removed by a single washing with $0.5\underline{N}$ H_2SO_4), reextraction of U from the triisooctylamine solution by nitrates, chlorides, alkali carbonates, and alkali sulfates. Reextraction by ammonium sulfate proves to be the preferred method at a pH of 4.5. Precipitation of ammonium uranate from this solution is effected by introduction of ammonia. The technique is closely tied to operation on a continuous basis. (BBB)

40817 LABORATORY EXTRACTION EQUIPMENT FOR THE REGENERATION OF IRRADIATED FUEL. 3. SOLUTION LEVEL MEASUREMENT. Zamek, Miroslav (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 266-9(Aug. 1969). (In Czech).

The design of an induction liquid level indicator for radiochemical work is presented. Changes of inductance with the liquid level position are caused by the nonuniform metering coil winding in the cavity of which there is a moving float with ferromagnetic material inside. Results of measurements are given, and equipment for sixteen measuring places is described. Accuracy of the measurement is approximately ±1% of the range. A calibration curve and the dependence of inductance of the probe on the position of the float are presented graphically. (auth)

40818 EXTRACTION OF HEAVY RARE EARTH ELEMENTS IN BIS(2-ETHYLHEXYL) PHOSPHATE. Mikhailichenko, A. I.; Pimenova, R. M. Zh. Neorg. Khim., 14: 1611-17(June 1969). (In Russian).

The isotherms for extraction of Ho, Er, Tm, Yb, and Lu by DEHPA from HCl and nitrate solutions were studied. Extraction of the metals increased in the series Ho < Er < Tm < Yb < Lu. Coefficients of separation of the binary systems Er–Ho, Tm–Er, Yb–Tm, and Lu–Yb were determined. Separation from chloride solutions was more efficient than from nitrate solutions. The magnitudes of the coefficients of separation depend on the acidity and the concentration of the metal. (tr-auth)

40819 THE NATURE AND EXTENT OF RADIOACTIVE WASTE DISPOSAL PROBLEMS. pp 84-92 of Water, Health, and Society. Selected Papers by Abel Wolman. White, Gilbert F. (ed.). Bloomington, Ind., Indiana University Press, 1969.

The management of radioactive waste materials follows two general precepts for the protection of man and his environment, for high-level radioactive wastes, concentrate and contain, and for low- and intermediate-level radioactive waste, dilute and disperse to nature. The nature of the problems encountered in the disposal of radioactive wastes is reviewed with respect to present quantities of wastes and also to prospects for the future. (D.H.M.)

40820 RAPID RADIOCHEMICAL SEPARATION METHOD FOR SELENIUM. del Marmol, P.; Van Tigchelt, H. (CEN-SCK, Mol, Belg.). Radiochim. Acta, 12: 57-9(July 1969).

A procedure based on hydride production for the separation of selenium from fission products is presented. Interference from other elements that form hydrides easily was found to be minimal. (J.G.B.)

40821 FAST SEPARATION OF SPALLATION PRODUCTS IN IRRADIATION OF AQUEOUS SUSPENSIONS OF SLIGHTLY SOLUBLE METAL OXIDES IN THE EXTERNAL BEAM OF THE SYNCHROCYCLOTRON. Malek, Z.; Pfrepper, G. (Joint Inst. for Nuclear Research, Dubna, USSR. Institut fuer Angewandte Radioaktivitaet, Leipzig). Radiochim. Acta, 12: 26-9(July 1969). (In German).

The quick separation of the target by simple filtration can be carried out successfully in an irradiation of aqueous suspensions of highly disperse target material with protons of an energy of 660 MeV, since a large fraction of the spallation products dissolves in the aqueous phase depending on its concentration. Sorption experiments of Ce(III) and Hf(IV) on highly annealed WO_3, Ta_2O_5, and HfO_2 showed that suspensions of WO_3 with $\geq 0.57\underline{N}$ HCl and HfO_2 and Ta_2O_5 with $0.1\underline{N}$ HCl can be used for the separation of rare earths. Ta_2O_5 was used with $0.5\underline{M}$ $(COOH)_2$ for the isolation of Hf. The practical yields of irradiation are 41% with Ta_2O_5 and 25% with WO_3 (grain size 0.5 to 2 μm). Hf becomes accessible 3.5 min after the end of irradiation, Lu, Yb, and Tm 13 to 20 min after the end of irradiation. It was possible with this method to investigate the hitherto unknown shortlived nuclides ^{167}Hf, ^{166}Hf, and ^{166}Lu as well as ^{168}Lu by nuclear spectroscopy. (auth)

40822 THIN-LAYER CHROMATOGRAPHIC SEPARATION OF Se(IV), Te(IV), V(V), AND Mo(VI) AS TERNARY MIXTURES AND THEIR IDENTIFICATION WITH POTASSIUM THIOCARBONATE (PTC) REAGENT. Johri, K. N.; Kaushik, N. K.; Singh, Kirpal (Univ. of Delhi). Mikrochim. Acta, No. 4, 737-40(1969).

Thin-layer chromatography of Se(IV), Te(IV), V(V), and Mo(VI) as ternary mixtures has been described. The separation was effected on a silica gel G layer by employing two different solvent systems: diethyl oxalate–HCl (60: 1 vol/vol) and n-butyl acetate–HCl (40: 0.6 vol/vol). The chromatograms were visualized with 0.1 $\underline{M}$ potassium thiocarbonate (PTC) spray and the limits of identification as determined, lie between 1.27 and 2.04 μg. (auth)

40823 QUANTITATIVE EXTRACTION OF VERY SMALL AMOUNTS OF IONS FROM VERY LARGE AMOUNTS OF WATER. IX. CONTRIBUTION ON COUNTERCURRENT ELECTROLYSIS. Reinert, K.; Thiemann, W.; Wagener, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Mikrochim. Acta, No. 4, 709-14 (1969). (In German).

A process, based on counter-current electromigration, is described for the quantitative separation of very small quantities of ions (e.g. radiochemical quantities) from very large amounts of water. In a small laboratory with 250 W electric power consumption, 0.5 t water/day were processed. The apparatus was used for preparing ^7Be from rainwater. (auth)

40824 REMOVAL OF YTTRIUM IONS FROM AQUEOUS SOLUTION BY ION FLOTATION. Rose, M. W.; Sebba, F. (Univ. of Witwatersrand, Johannesburg). J. Appl. Chem. (London), 19: 185-7(July 1969).

Conditions for the concentration of yttrium from aqueous solution by ion flotation using α-sulphonated fatty acids were studied. The effects of change of collector and colligend concentration and pH, as well as the effect of interfering ions, were investigated. Maximum recovery was 99.5%. (auth) (UK)

40825 TREATMENT OF MARY KATHLEEN URANIUM ORE: A REVIEW. Hartley, F. R. pp 138-60 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16-21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.
See CONF-680654.

Four published accounts of the mineralogy, milling and leaching, solids-liquid separation, ion exchange, precipitation and drying, and reagent aspects of the treatment of uranium ores from the Mary Kathleen mine near Cloncurry, North Queensland are reviewed. Some new information is given on peculiarities of the ore, and treatment problems. Microprobe analysis of the host minerals allanite and stillwellite is illustrated. All main minerals broke in a granular fashion. The pulp had low viscosity compared with most silicate slurries. A pulp (60 per cent by weight of solids) could be produced. The host minerals were highly reactive in acid and pH control was mandatory in the leaching process. Allanite, stillwellite, and apatite dissolved readily in fairly low concentrations of acid leading to difficulty in thickening the leached slurries and extreme resin fouling in the extraction plant. Optimization of leaching conditions is illustrated. (Australia)

40826 THE TREATMENT OF SOUTH ALLIGATOR VALLEY URANIUM ORES. Murray, R. J.; Fisher, W. J. pp 125-37 of

Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.

See CONF-680654.

The treatment of the South Alligator Valley uranium ores passed through three phases dictated by economic circumstances during the years 1956 to 1964. In the first phase high grade ores were treated by hand sorting and wet gravity separation for recovery of high grade concentrate to meet a United States Atomic Energy Commission (U.S.A.E.C.) contract for plus 50 per cent pitchblende concentrates. Secondly tailings from the gravity plant and some high grade ores were trucked to Rum Jungle and sold to the Australian Atomic Energy Commission (A.A.E.C.). Thirdly solvent extraction plants were built at Moline (previously Northern Hercules) by United Uranium N.L. (U.U.N.L.) and at the South Alligator River by South Alligator Uranium N.L. (S.A.U.N.L.). These were the first solvent extraction plants designed in Australia, as earlier plants used the ion exchange process for recovery of uranium oxide. The plants were small, indeed the S.A.U.N.L. 15 ton per day plant was possibly the smallest commercial plant known, but they operated efficiently with good recoveries, and were placed on a care and maintenance basis when contracts were filled. Sulphuric acid was supplied in bulk to both plants by the A.A.E.C. from the 30 ton a day acid plant at Rum Jungle. Gold was recovered as a by product of uranium ore from the Moline plant. (auth) (Australia)

40827 TREATMENT OF RUM JUNGLE URANIUM ORE. Allman, M. B.; Harris, J. A.; Bayly, M. G. pp 90-124 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.

See CONF-680654.

The current operational practice at the Territory Enterprises Pty. Limited uranium oxide plant, and some aspects of research and development work at Rum Jungle are outlined with pertinent comments on some overseas practices. (auth) (Australia)

40828 COMPLEXES FORMED IN THE CHLOROFORM EXTRACTION OF URANIUM(VI) WITH OXINE. Oki, Shohachiro (Shizuoka Univ., Hamamatsu, Japan). Talanta, 16: 1153–8(Aug. 1969).

Equilibrium distribution ratios were determined for uranium(VI) with oxine between chloroform and 0.1 M perchlorate as a function of pH and reagent concentration at 20°. It was concluded that the extractable complex is UO_2Ox_2HOx. The equilibrium constants for the extraction of uranium were determined as $K_{U,1} = [UO_2Ox_2HOx]_0/[UO_2^{2+}][Ox^-]^3[H^+] = 10^{36.18}$ at low pH and $K_{U,2} = [UO_2Ox_2HOx]_0/[UO_2Ox_2OH^-][Ox^-][H^+]^2 = 10^{25.40}$ at high pH. (auth) (UK)

40829 SEPARATION OF TERVALENT RARE EARTHS AND SCANDIUM FROM ALUMINIUM, IRON(III), TITANIUM(IV), AND OTHER ELEMENTS BY CATION-EXCHANGE CHROMATOGRAPHY IN HYDROCHLORIC ACID–ETHANOL. Strelow, F. W. E.; Baxter, Cynthia (National Chemical Research Lab., Pretoria). Talanta, 16: 1145-51(Aug. 1969).

Tervalent rare earths and Sc were separated from the silicate-forming elements Al, Fe(III), Mg, and Ti(IV), and also from Mn(II), U(VI), Be, Ga, In(III), Tl(III), Bi(III), Ni, Zn, Cu(II), Cd, and Pb by cation exchange chromatography. The other elements were eluted with 3.0 M HCl containing 50% ethanol from a column of 60 ml of AG50W-X8 resin (200–400 mesh), while the rare earths were retained. Separation factors were larger than in aqueous hydrochloric acid. Th, Zr, Hf, Ba, Sr, Ca, K, and Rb were the only elements that accompany the rare earths group, but these can easily be separated by other methods, which are described. Relevant distribution coefficients, elution curves, and accurate results of quantitative separations of synthetic mixtures are presented. (auth) (UK)

40830 ^{13}C FRACTIONATION BETWEEN ARAGONITE AND CALCITE. Rubinson, Michael; Clayton, Robert N. (Univ. of Chicago). Geochim. Cosmochim. Acta, 33: 997-1002(Aug. 1969).

Aragonite and calcite were precipitated from bicarbonate solutions by slow removal of carbon dioxide at 25°C. Carbon isotope fractionation factors (expressed as 1000 $\ln\alpha$) were: calcite–bicarbonate ion 0.9 ± 0.2; aragonite–bicarbonate ion 2.7 ± 0.2; aragonite–calcite 1.8 ± 0.2. Theoretical calculation of the aragonite–calcite fractionation gave 0.9. (auth) (UK)

40831 RADIOCHEMICAL SEPARATIONS BY THE RING-OVEN TECHNIQUE. IV. THE SYSTEM $^{144}Ce/^{144}Pr$. Klockow, D.; Boehmer, R. G. (Univ., Freiburg i. B.). Talanta, 16: 1209-11(Aug. 1969).

By using filter papers impregnated with a manganese oxide hydrate having an average oxidation number of +3 it is possible to separate ^{144}Pr from ^{144}Ce rapidly by the ring-oven technique. With 0.06 to 0.07 M trichloracetic acid as wash-solution the daughter nuclide can be concentrated in the ring zone with 80 to 90% yield and decontamination factors $>10^3$. The half life of the separated ^{144}Pr was found to be 17.60 ± 0.05 min. The behavior of other fission nuclides under the same conditions was also investigated. (auth) (UK)

40832 METHODS FOR THE PROCESSING OF RADIOACTIVE WASTES. Ramdohr, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Kerntechnik, 11: 390-6(July 1969). (In German and English).

The processing of radioactive residues has the double purpose of producing, from the primary raw wastes generated in various phases of the fuel cycle, concentrates in a form suitable for storage and for definitive disposal and waste waters and other wastes that can be disposed of by the usual methods of industrial wastes disposal. The commonly used processing methods for solid, liquid, and gaseous radioactive wastes are discussed. (auth)

40833 SEPARATION OF TITANIUM, ZIRCONIUM, CERIUM, AND THORIUM FROM METAL IONS FORMING THIOCARBONATO-COMPLEXES WITH POTASSIUM THIOCARBONATE (PTC) REAGENT. Mittal, I. P.; Singh, Kirpal (Shyam Lal Coll., Delhi). Curr. Sci. (India), 38: 386-7(Aug. 20, 1969).

Separation of Ti, Zr, Ce, and Th, one at a time, from Cu, As, Sb, Se, Te, Mo, and Fe is described. When an excess potassium thiocarbonate solution is added to an aqueous solution of these ions, Ti, Zr, Ce, and Th are precipitated as hydroxides and the other ions remain in solution in soluble thiocarbonato-complexes. (M.C.G.)

40834 ANION-EXCHANGE BEHAVIOUR OF SEVERAL ELEMENTS IN HYDROBROMIC ACID–ORGANIC SOLVENT MEDIA. Klakl, E.; Korkisch, J. (Univ., Vienna). Talanta, 16: 1177-90 (Aug. 1969).

The anion exchange behavior of 19 elements in hydrobromic acid–organic solvent media was investigated. The batch distribution coefficients of the metal ions were determined in these systems employing the strongly basic anion exchange resin Dowex 1, × 8. Organic solvents used were methanol, ethanol, n-propanol, isopropanol, methyl glycol, acetone, tetrahydrofuran, and acetic acid. The most suitable conditions for some quantitative separations based on these equilibrium studies are indicated and discussed. Elements studied included U, Th, Ce, Mo, V, Sr, Co, Fe, Al, In, Bi, Mg, Ca, Pb, Zn, Cd, Cu, Mn, and Ni. (auth) (UK)

40835 CHEMICAL PART OF THE NUCLEAR FUEL CYCLE. Leger, J. E. (Departement Recherches et Developpement Atomiques, Paris). Atomwirt., Atomtech., 14: 300-2(June 1969). (In German).

Ore processing and concentration, conversion to UF_6, production of UO_2 from UF_6, transformation of UO_2 powders to tablets, and processing of fission products from irradiated fuel are discussed. (M.C.G.)

40836 THE SYNERGISTIC EFFECT IN SOLVENT EXTRACTION. THE EFFECT OF CARBOXYLIC ACID ON THE SOLVENT EXTRACTION OF EUROPIUM(III) WITH BENZOYLTRIFLUOROACETONE. Shigematsu, Tsunenobu; Tabushi, Masayuki; Matsui, Masakazu; Honjyo, Takaharu (Kyoto Univ.). Bull. Chem. Soc. Jap., 42: 976-80(1969).

The effects of carboxylic acids, such as formic, chloroacetic, acetic, propionic, butyric and caproic acid, on the extraction of europium with benzoyltrifluoroacetone were studied. The extraction is enhanced by the adduct formation between metal chelates and carboxylic acids in the organic phase, while it is hindered by the formation of metal-complex ion with anions of carboxylic acids in the aqueous phase. Caproic acid acts as an organic Lewis base and shows the synergism, but formic and chloroacetic acids have a masking effect. Acetic acid, propionic acid, and butyric acid behave both as synergists in the organic phase and as masking agents in the aqueous phase. Caproic acid forms more stable adducts than does n-hexyl alcohol, and the composition of the chelate adduct is estimated to be $Eu(BFA)_3 \cdot 2CH_3(CH_3)_4COOH$. (auth)

40837 A REVIEW OF THE LITERATURE OF 1967 ON WASTEWATER AND WATER POLLUTION CONTROL. Weiss, C. M.; Engelbrecht, R. S.; Alspaugh, T. A.; (and others). J. Water Pollut. Contr. Fed., 40: 897-1222(June 1968).

The development of rapid and reliable methods for determination of total organic carbon or total organic materials is reviewed, along with methods for anions, cations, and dissolved gases. Increasing emphasis on instrumental and automated analytical methods is discussed. Use of activation techniques is described. Treatment of waste water with biological filters, the activated sludge process, use of lagoons and oxidation ponds, effects of detergents on treatment of waste water, anaerobic processes, sludge treatment and disposal or utilization, disinfection processes and the potential of water reclamation and reuse are discussed. Sewage and storm flow treatment, methods for evaluation of facility operation, kinetic models for aqueous systems, and physical and chemical methods of waste water treatment are considered. Effects of pollution on fish life, on macroinvertebrates, and freshwater microfauna are described. The problems caused by eutrophication and biological effects of thermal pollution are discussed. The microbiology of waste water is described. Oxygen sag and stream self-purification and pollution of surface waters, ground waters, and bottom deposits are considered. Marine and estuarine pollution are discussed along with effects of pollution on marine biology. Systems analysis and its applications to the planning, design, and operation of river basins are described. Economics, law, and administration are reviewed. Stream surveys and data evaluation techniques are considered and stream standards adopted. Industrial wastes from paper and allied products, the fermentation industry (including pharmaceuticals, corn, and sugar), the meat and poultry processing industry, canning industries, dairying, livestock handling, coal mining, the tannery and textile industries, steel production, petroleum processing, metal plating, and the chemical industry are discussed. Processing of radioactive wastes are also considered. (2575 references) (M.C.G.)

40838 PROSPECTS OF WATER PURIFICATION IN NUCLEAR POWER PLANT CYCLES WITH POWDERED ION EXCHANGE RESINS. Martynova, O. I.; Subbotina, N. P.; Kopylov, A. S. At. Energ. (USSR), 27: 91-5(Aug. 1969). (In Russian).

Published and experimental data on powdered resin sorption of various contaminants typical for nuclear power plant condensates at temperatures up to 140°C are given. Attention is drawn to the high corrosion products (iron, zinc, copper) holding capacity of powdered resins KU-2 and AW-17 (15 to 30% by dry resin-mixture weight), ion exchange capacity (5 to 7%), and radioactive decontamination factors (DF average = 10 to 15). The suitability of precoated resin filters for various nuclear power plant water treatments and their use at high temperatures are discussed. (auth)

40839 EXTRACTION OF URANIUM(VI) FROM BICARBONATE–OXALATE LEACH SOLUTION WITH ANION EXCHANGE RESIN. Ishijima, Itaru; Funaki, Koemon (Tokyo Inst. of Tech.). Kogyo Kagaku Zasshi, 72: 1232-8(June 1969). (In Japanese).

A method is described for concentration and purification of leached solutions from a proposed bicarbonate–oxalate process for extraction of U(VI). A column of anion exchange resin (Amberlite IRA-400) was used. The saturation and breakthrough capacities of U(VI) adsorbed from the leached solution increased with concentration of U, and decreased with increasing concentration of oxalate. Uranium(VI) was extracted mainly as $UO_2(CO_3)_3^{4-}$ on contrast to an amine extraction process, where it was extracted as $UO_2(C_2O_4)_3^{4-}$. A mixed solution of NaCl (1M) and sodium bicarbonate (0.5M) was found suitable as an eluent. Under optimum conditions, the concentration of U increased by about 10 times with a yield of about 94%, the Si/U ratio reduced to nearly 0, and the Al/U ratio reduced to about 30% compared with the original solution. It was concluded that the hydration number of an ion may be estimated from the volume of swelled resin, and that there was a linear relation between the hydration number of an anion and the selectivity coefficient. (NSA of Japan)

40840 FISSION PRODUCT TRAPPING SYSTEMS. Taylor, Roland (to United Kingdom Atomic Energy Authority). U. S. Patent 3,453,807. Priority date June 22, 1965, Great Britain.

Alkyl halides, such as methyl iodide, which may be released as fission products from irradiated nuclear fuel, are trapped by system comprised of charcoal impregnated with a water soluble tertiary or secondary amine to remove the alkyl halide from a gas stream. (Offic. Gaz.)

40841 METHOD OF ^{137}Cs REMOVAL. Bonnin, Andre; Poirier, Philippe (to Societe Saint-Gobain Techniques). U. S. Patent 3,453,214. Filed Feb. 14, 1967.

Cesium-137 was separated from radioactive effluents by passing the solution through a column loaded with mixed ferrocyanides that have been previously adsorbed on an anionic resin or glass fiber bed. (Offic. Gaz.)

40842 SEPARATION OF RARE EARTH ELEMENTS. Sherrington, Leonard George; Hewitt, James Maurice (to Thorium Ltd.). U. S. Patent 3,453,069. Priority date Feb. 4, 1966, Great Britain.

Europium is separated from a mixture of rare earths by providing an aqueous solution containing trivalent rare earth ions and divalent europium ions, precipitating the trivalent rare earth ions with MgO, filtering the mixture and recovering europium from the filtrate. (Offic. Gaz.)

40843 A SIMPLIFIED AND GENERALIZED METHOD FOR ANALYZING CHROMATOGRAPHIC ISOTOPE SEPARATION DATA. Kakihana, Hidetake; Kanzaki, Tadao (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 77-89(Mar. 1969).

A simplified and generalized equation for analyzing isotope separation data experimentally obtained by electromigration and ion-exchange chromatography was derived. $S \equiv 1 + \epsilon = 1 + D/Q \cdot 1/R_0$, where ϵ and S are the relative difference in migration velocity of isotopes and the single stage, elementary, separation factor, respectively, Q is the isotropic total capacity of the ion-exchange membrane or the ion-exchange column of migration length, D is the depleted amount of isotope M_1 at the rear or frontal part of the adsorbed band of isotopes or the enriched amount of isotope M_1 in the ion-exchanger after operation. $1 + \epsilon$ and S given by the above equation have exactly the same physical meaning and make possible the mutual comparison of the two isotope separation processes: the electromigration and the ion-exchange chromatography. (NSA of Japan)

40844 CONVERSION AND CONTAINMENT OF RADIOACTIVE ORGANIC LIQUIDS INTO SOLID FORM. Fitzerald, C. L.; Godbee, H. W.; McCorkle, K. H. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,473,738. Aug. 26, 1969.

Radioactive organic liquids are effectively converted into solid form by homogeneously mixing liquefied polyethylene with the radioactive liquids and cooling the resulting mixture to form a solid, essentially nonporous, rigid polyethylene body that effectively contains the radioactivity. (AEC)

40845 RECOVERY OF AMERICIUM FROM PLUTONIUM METAL USING MOLTEN SALTS. Long, Jack L. (to U. S. Atomic Energy Commission). U. S. Patent 3,460,917. Aug. 12, 1969.

Americium was extracted from Pu by agitating a molten mixture of Pu containing Am with an equimolar mixture of NaCl and KCl containing $MgCl_2$ in which the salt/Pu weight ratio is at least about 0.4. (AEC)

40846 SOLVENT EXTRACTION PROCESS FOR PURIFYING AMERICIUM AND CURIUM. Ritter, Gerald L.; Bray, Lane A. (to U. S. Atomic Energy Commission). U. S. Patent 3,463,619. Aug. 26, 1969.

A solvent extraction process is described for purifying Am and/or Cm contained in an aqueous feed solution along with rare earths and other values by extracting the lanthanide rare earths, Y, U, Am, and Cm values present with bis(2-ethylhexyl) ester of phosphoric acid and tributyl phosphate in a normal paraffin hydrocarbon from the feed solution to which has been added hydroacetic acid and diethylenetriaminepentaacetic acid. The Am and/or Cm values are then separated from the lanthanide rare earths, Y, and U present and from the other elements, e.g., Pu, which are extracted to a small extent by contacting the organic phase with an aqueous solution of hydroxyacetic acid and diethylenetriaminepentaacetic acid. The values are then recovered from the aqueous phase by precipitation with oxalic acid. (AEC)

40847 A RAPID METHOD FOR SEPARATION OF RADIOCESIUM FROM WATER SAMPLES. Haberer, Klaus; Weindel, Werner GWF (Gas-Wasserfach), 107: 892-6(Aug. 1966). (In German).

Radiocesium is separated from water samples by simple filtration through a paper filter that was previously treated with ammonium molybdophosphate. There is a certain maximum filtration rate and a pH dependence for the method, though the limitations are not so great to prevent easy application in water filtration plants. Studies are reported on efficiency at different rates of filtration, rate of loss of molybdophosphate in NaCl and $Ca(NO_3)_2$ solutions, effect of multiple layers of filter paper on efficiency, and γ spectra of collected samples from rain water. Other radioisotopes are collected by this technique, notably ^{144}Ce and ^{141}Ce, with small amounts of ^{131}I, ^{106}Rh, ^{103}Ru, ^{140}La, ^{95}Zr, and ^{95}Nb. These radionuclides are effectively removed by washing the filter with 1N HNO_3. Two filters produced analyses of 75 to 82% of the ^{137}Cs in natural water samples (spring, ground, river, and seawater) when the pH was 3 after adjustment with HNO_3. (BBB)

40848 RECOVERY OF MERCURY FROM NUCLEAR FUEL REPROCESSING WASTES. Rhodes, Donald W.; Wilding, Malcolm W. (to U. S. Atomic Energy Commission). U. S. Patent 3,463,635. Aug. 26, 1969.

A process is described for recovering Hg metal, present in acidic aqueous solutions as the mercuric ion, by adding hydrazine hydrate to the solution and refluxing the solution until the mercuric ion is reduced to mercury metal. (AEC)

40849 EFFECT OF Al^{3+} AND H^{+} UPON THE SIMULTANEOUS DIFFUSION OF ^{85}Sr AND ^{86}Rb IN KAOLINITE CLAY. Brown, D. A.; Phillips, R. E.; Ashlock, L. O.; Fuqua, B. D. (Univ. of Arkansas, Fayetteville). Clays Clay Miner., 16: 137-46(July 1968).

The effect of varying concentrations of Al^{3+} and H^{+} on the simultaneous diffusion of ^{85}Sr and ^{86}Rb was measured in salt-free aliquots of clay having different Al : H ratios. The ^{85}Sr and ^{86}Rb saturation was held constant while the exchangeable Al and H were varied from $Al_{12} : H_1$ to $Al_{12} : H_{34}$. Self-diffusion of ^{85}Sr and ^{86}Rb was measured at 4, 24, 48, and 75°C. Radioassay of ^{85}Sr and ^{86}Rb was made with an automatic γ detection system equipped with a 400-channel analyzer and card punch unit. The self-diffusion equation was programmed for the 7040 computer to permit the simultaneous calculation of ^{85}Sr and ^{86}Rb self-diffusion coefficients. Diffusion of ^{86}Rb was not significantly altered as the Al^{3+} concentration was increased from 12 to 52%. The diffusion of ^{85}Sr was significantly increased as Al^{3+} increased from 12 to 52%. The faster diffusing Rb ion had a greater energy of activation than Sr (4.8 to 3.6 Kcal/mole); however, the Arrhenius frequency factor for Rb (a measure of the probability of ion exchange) was much greater for Rb and Sr (28.8 and 0.4×10^{-4}, respectively). (BBB)

40850 CHEMICAL DECLADDING: THE EXPERIENCE GAINED AT EUROCHEMIC. Detilleux, E. (Eurochemic, Mol, Belgium). Energ. Nucl. (Paris), 11: 292-7(July 1969). (In French).

The reasons why chemical decladding was selected for the Eurochemic plant are recapitulated. The equipment that has been installed is described and comments are made upon the chemical aspects of the decladding methods that are being used. The experience gained during the first thirty months of operation is then described. In spite of the difficulties encountered in the application of the Zirflex process, which is used for decladding Zircaloy-clad fuels, chemical decladding can be considered as an industrial operation. Some indications concerning the future programme of Eurochemic are given. (auth)

40851 COMPARISON OF THE ECONOMICS OF WET AND DRY REPROCESSING. Thiriet, L. Eng. Nucl. (Paris), 11: 298-305(July 1969). (In French).

The development of nuclear power programs will demand growing fuel reprocessing capacities at the least cost. Will it be preferable to build a very few large plants, profiting from scale-up, or, on the contrary a fairly large number of small plants distributed so as to reduce shipping costs? The global model developed by C.E.A. to solve this problem is presented. Dealing with breeder plants, it will make it possible to appreciate fully the economics of dry processing as compared to wet processing. (auth)

40852 METHOD OF SEPARATION OF ISOTOPES BY GAS-ION EXCHANGE IN SOLID ION EXCHANGERS. Safonov, M. S.; Gorshkov, V. I.; Bairamov, V. T. (Moscow State Univ.). Zh. Fiz. Khim., 43: 1635-6(June 1969). (In Russian).

Isotope separation by exchange between gas and ions in solid ion exchangers was studied. Examples of such reactions are given for ^{14}N-^{15}N, ^{34}S-^{32}S, and ^{13}C-^{12}C. The countercurrent separations were carried out on columns 150 cm high and 25 mm in diameter. (M.C.G.)

40853 DECONTAMINATION OF THORIUM WASTES. Przytycka, Roza; Olech, Barbara (Instytut Badan Jadrowych, Warsaw). Nukleonika, 14: 41-7(1969). (In Polish).

Wastes obtained from the isolation of thorium from solutions after leaching of thorium ores were decontaminated by the method of coprecipitation with calcium oxalate. The influence of the pH of the solution and the quantity of added oxalic acid on the isolation of the thorium from the wastes investigated were examined. Conditions leading to high decontamination of thorium wastes were established. (auth)

40854 METHOD AND APPARATUS FOR ENRICHING ELECTROLYTICALLY WATER IN TRITIUM. Padzik, Andrzej; Soltyk, Wojciech (Przedsiebiorstwo Hydrogeologiczne, Warsaw). Nukleonika, 14: 87-95(1969). (In Polish).

The electrolytic method for enriching water with tritium as well as the construction of the set of electrolytic cells is described in detail. This apparatus was used for measuring the enrichment factor, β, for tritium, when the initial volume of the samples was $V_0 = 450$ cm^3 and the initial activity, T_0, was known. Seven water samples were electrolyzed simultaneously at constant temperature $t = 2$°C and total current $I = 10$ At. The electrolyses were carried out without periodic addition of water. The results obtained confirmed good stability and reproducibility of the enrichment factor, β, and the suitability of the apparatus used on such large scale. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 40564, 40605, 40792, 40874, 40878, 41021, 41081, 41082, and 41314.

40855 (ARH-SA-47) THE HANFORD EXPLORATORY DEEP WELL. Isaacson, R. E. (Atlantic Richfield Hanford Co., Richland, Wash.). July 16, 1969. Contract AT(45-1)-2130. 18p. Dep. CFSTI.

A deep well was drilled on the Hanford Area to obtain rock and water samples for evaluating the geologic and hydrologic characteristics of the underlying rock strata, which in turn can be used to determine whether the deep basalt flows are thick enough and impermeable enough to store radioactive wastes for hundreds to thousands of years in mined out caverns isolated from the biosphere. As of July 12, 1969, the well was 4,282 feet deep. Geophysical logs to that depth have been obtained. Hydrologic tests are being conducted, and core drilling is proceeding. Information obtained so far indicates that several layers of basalt are thick enough to mine out and appear to be impermeable enough to assure that wastes will not migrate through the rock into more permeable zones and hence into the biosphere. The specific depths of these zones are given. (L.C.L.)

40856 (IDO-12071, pp 32-4) U. S. GEOLOGICAL SURVEY. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

Progress is reported on studies conducted during 1968 of the NRTS ground-water hydrologic system. A study was made to determine the reason for the increase in tritium concentrations in the water from the ICPP production wells. Underground radioactive gas injection tests were analyzed to determine the effects of molecular diffusion on radioactive ^{133}Xe diffusion. The tests were analyzed by mathematical models and digital computers. Investigations were made on the transmission of seismic effects as a result of a proposal to fire large caliber naval guns at NRTS. Studies were conducted on the effects of underground waste disposal on contamination of ground waters. (R.C.K.)

40857 (NYO-844-76) NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH. Progress Report, 1968–1969. Kohman, Truman P. (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). June 30, 1969. Contract AT(30-1)-844. 107p. Dep. CFSTI.

Research progress is reported under the following headings: Moessbauer spectroscopy of natural materials; alpha spectroscopy of natural materials; alpha spectroscopy of uranium in tektites; geochronological potential of the ^{40}K$-^{40}$Ca system; isotopic composition of lead and thallium in meteorites; investigation of the ^{147}Sm$-^{143}$Nd and ^{146}Sm$-^{142}$Nd systems as dating methods; possible additional cases of extinct natural radioactivity; concentrations of gold, silver, and indium in semiconductor silicon; segregation of antimony in a nickel–chromium alloy steel during temper embrittlement; instrumentation; fast gamma-gamma coincidence spectrometry for activation analysis; gamma-gamma coincidence spectrometer for measuring low-level gamma emitters; and least-squares fitting of data with large errors. (M.C.G.)

40858 (USGS-474-15) SUMMARY GEOLOGIC REPORT ON THE UE20p EXPLORATORY HOLE, AREA 20, PAHUTE MESA, NEVADA TEST SITE. Jenkins, Evan C. (Geological Survey, Denver, Colo.). Apr. 1969. 20p. Dep. CFSTI.

Exploratory drill hole, UE20p, was drilled to a total depth of 5,000 feet. Serious caving produced fill and bridge problems that necessitated the drilling of a side-track drill hole to a total depth of 4,480 feet. The caving problems may be attributed almost entirely to extreme alteration of the rock, probably by hydrothermal solutions, that thoroughly weakened it. Major units in UE20p were correlatable to a depth of 3,326 feet with units in UE20j and Pahute Mesa Exploratory Hole No. 2. Below that depth alteration is similar in all three drill holes and, as a result, correlation is difficult. Hydrologic tests show that the altered rocks should be extremely impermeable. (auth)

40859 TRITIATED WATER DISTRIBUTION IN UNSATURATED SOIL. Schmalz, Bruce L.; Polzer, Wilfred L. (Atomic Energy Commission, Idaho Falls, Idaho). Soil Sci., 108: 43-7 (July 1969).

On the basis of tritium concentration measurements in soil water, it was concluded that approximately 3.5 per cent of the tritium which occurred at the Southeastern Idaho location during a 15-year period remained in the top 200 centimeters of the soil profile while the rest was lost by evaporation or transpiration. The observed distribution compared with that calculated by a mathematical model based on diffusivity and convective processes. Diffusivity values acceptable by the model varied within a range of 0.9×10^{-6} to 9×10^{-6} cm^2/sec. Acceptable values for velocity varied within a smaller range of 8 to 10.4 cm per three-month period. (auth)

40860 HEATING EFFECTS ON THE THERMOLUMINESCENCE OF GAMMA IRRADIATED SOILS. Nishita, H.; Hamilton, M. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Soil Sci., 108: 1-10(July 1969).

The effects of pre-irradiation and post-irradiation heating on the thermoluminescence of several soils exposed to ^{60}Co gamma rays were studied. The soils examined showed two general effects of pre-irradiation heating. With one group of soils, the shallow electron (and hole) traps increased, while the deep traps were decreased by increasing the heating temperature. The thermoluminescence capacity of these soils was reduced at high temperatures. With the other group of soils, there was an increase of the traps of intermediate depth, while shallower and deeper traps decreased. The thermoluminescence capacity of these soils was increased by heating. The pre-irradiation threshold temperature below which the shape of the glow curve did not change and full thermoluminescence capacity was recoverable appeared to be around 100°C. Some attempts were also made to determine the effects of pre-irradiation heating on 3 clay minerals (bentonite, illite, and kaolinite) and certain salts ($CaSO_4$, $CaCO_3$, CaO, MgO, $MgCO_3$, Na_2CO_3, and K_2CO_3). Post-irradiation of a soil decreased the thermoluminescence over the entire range of the glow curve. The low temperature traps, however, were decreased more than that of the high temperature traps, as expected. Heating to a temperature of around 300°C was necessary to completely deexcite the natural thermoluminescence of the soil examined. (auth)

40861 WATER, HEALTH, AND SOCIETY. Selected Papers by Abel Wolman. White, Gilbert F. (ed.). Bloomington, Ind., Indiana University Press, 1969. 410p. $15.00.

Thirty-two papers on water supply are presented dealing with problems ranging from the broad field of water resources through questions of technology, policy, and organization to the ethics of a profession. The material is presented under six major headings: water resources, water quality and treatment, the search for standards, water planning and policy, comprehensive planning for human environment, and the role of the engineer. A separate abstract was prepared for one paper. (D.H.M.)

For an abstract of the individual chapter see: 40819.

40862 ^{137}Cs IN AN ALPINE WATERSHED. Hubbard, John Edward. Fort Collins, Colo., Colorado State Univ., 1968. 107p. Thesis.

A study was made of the distribution of the fallout radionuclide ^{137}Cs on the surface and in the stream channel of an alpine watershed in the Colorado Front Range. ^{137}Cs activities of the surface (mean = 222 nCi/m^2) were considerably higher than at Fort Collins, Colorado. The effects of snow-accumulation, soil-vegetation complexes, and the hydrologic surface were studied in relation to ^{137}Cs activity. Snow-accumulation areas contained significantly more ^{137}Cs than snow-free areas. Alpine Bog contained significantly more ^{137}Cs than did Alpine Turf and Alpine Meadow soils. Micro-channels and micro-depressions had significantly higher levels of ^{137}Cs activity than areas characterized as surface runoff. Concentrations of ^{137}Cs in stream bottom sediments and stream vegetation decreased exponentially downstream with distance from a permanent snowfield at the headwaters. There is some evidence that ^{137}Cs in sediments is accumulating in a marshy area where the stream flows across the moraine of a former mountain glacier. ^{137}Cs activities of the sediments were not highly related to percent silt + clay. Evidence did not support the hypothesis that most ^{137}Cs would concentrate in the silt + clay as it moved downstream. Significant quantities of ^{137}Cs were not found in stream water or the 1967 or 1968 snowpack. Measureable ^{137}Cs activities were found in litter and inorganic materials in and about the permanent snowfield, and in moss on rocks in the stream channel. (Diss. Abstr.)

40863 PROVING AQUATIC LIFE AND A NUCLEAR PLANT CAN EXIST IN HARMONY. EEI (Edison Elec. Inst.), Bull., 37: 146-7(May 1969).

A 250-ft scale model of a 14-mile segment of the lower Susquehanna River was constructed to study river flow and temperature as will be present when 3 nuclear power units are in operation, probably in mid-1973, at Peach Bottom, Pa. The objective is to provide guidelines to plant operators on how much heat can be discharged safely into a river as its flow, water temperature, and surrounding weather conditions change. Concern was expressed that the variety of fish may be altered by heating the water, but results of the study on how effectively the river can handle heat and of the temperature preferences of the fish have indicated that this may not be so. The study prompted redesign of the outlet from which heated water from the plants will be fed into the river. It formerly spilled over a shallow spillway so that the heated water spread out over the surface of the river, on the theory that evaporation would remove the heat. Now the channel ends in a narrow, vertical gated structure that acts as a jet to propel the heated water into the river with considerable turbulence below the surface of the river. The mixing effect dissipates the heat more quickly. The river cannot handle all of the heat from the 3 plants. Part of it will be removed by cooling towers in which fans circulate air over water pipes to cool the water before it goes into the discharge channel. (BBB)

40864 DIRECT MEASUREMENT OF ^{220}Rn (THORON) EXHALATION FROM THE GROUND. Crozier, W. D. (New Mexico Inst. of Mining and Tech., Socorro). J. Geophys. Res., 74: 4199-4205(Aug. 15, 1969).

A method has been devised for direct measurement of the ^{220}Rn flux through the ground surface ("exhalation"), and measurements are reported for six sites. At one site comparisons are made between the measured exhalation and those exhalations deduced from ^{220}Rn profiles in the air above the site; agreement is good with low intensity of turbulence. The discrepancies with higher turbulence are discussed. (auth)

40865 URANIUM IN LAKE WATER FROM THE KAIPOKOK REGION, LABRADOR. Meyer, W. T. Quart. Colo. Sch. Mines, 64: 377-94(Jan. 1969).

The uranium content of lake water was examined in an orientation survey covering the area of known mineralization in the Kaipokok region of Labrador. This sampling program established procedures that were later used in the reconnaissance survey of a 500-square-mile region. Sixty to 70 small lakes were sampled each day. The shallow lakes of the Kaipokok region are glacial in origin, most occurring in irregular depressions within ground moraine and in ice-scour rock basins. Small seepage ponds were sampled in preference to lakes forming part of an established drainage system. Seasonal variations in U concentration were apparent in a comparison of data from lakes sampled in both September and July, with a 3- to 4-fold increase in the lake water U content in the autumn. This factor contributed to a median U concentration of 0.4 ppB for the orientation survey, compared with the 0.1 ppB median value of the mid-summer regional sampling. The frequency distributions of U content in lake water were approximately log-normal in both cases. Rolling mean analysis applied to the regional survey data provided an outline of regional trends for U and related high samples to a local background. The biochemical cycle of U was found to be particularly important in interpreting results due to the accumulation of U in the organic material contributed by marginal swamps. Data from the lake water surveys compared favorably with the results of airborne geophysical surveys. (BBB)

40866 RADIONUKLIDE IM WASSER. IHRE VERBREITUNG, ANWENDUNG, MESSUNG UND ENTFERNUNG. (Radionuclides in Water. Distribution, Application, Measurement, and Removal). Haberer, Klaus. Thiemig-Taschenbuecher, Band 17. Muenchen, Ger., Verlag Karl Thiemig KG, 1969. 319p. DM 19,80.

Topics covered include: properties of radioactive materials and their effects on man; measurement of radioactive materials in water; origin, distribution, and properties of radioactive materials in waters; the behavior of radioactive materials in soils and waters; the removal of radioactive material from water; and the use of radionuclides in the hydroeconomy. (M.C.G.)

40867 MODERN ASPECTS OF RADIOCARBON DATINGS. Olsson, Ingrid U. (Univ. of Uppsala). Earth-Sci. Rev., 4: 203-18(Sept. 1968).

Theoretical and practical features of the radiocarbon method for radioactive age estimations are discussed and recent developments in determining the half-life time of ^{14}C are reviewed. The occurrence and causes of variations in the ^{14}C/^{12}C ratio are outlined, as are the possibilities and influence of contamination. Applicability and reliability of the method are also considered. The ^{14}C dating method is based on the principle that ^{14}C is produced by cosmic rays and is mixed with the inactive C in the atmosphere. It is assimilated by plants or dissolved in water, and takes part in the carbon cycle in nature. Living material compensates the decay of ^{14}C by assimilation or by intake of food, and an equilibrium is established during its life time. When the supply stops with the death of the organism, the decay of ^{14}C is no longer compensated and can be measured to determine the time which has elapsed since death. Cosmic ray production of ^{14}C from ^{14}N is discussed. Since the geomagnetic field varies, its shielding effect on the cosmic radiation will cause changes in the ^{14}C production. Also, variations in the solar wind intensity affect the deflection of the cosmic rays. On the other hand, an increase of neutrons produced by protons from the solar flares causes an increase of ^{14}C production. The amount of ^{14}C produced by the solar protons is, however, less than 5% of that produced by the cosmic radiation. The relation between the CO_2 reservoirs also affects the ^{14}C/^{12}C ratio as does the temperature and pH of the oceans. Isotopic fractionation might also occur, which easily can be detected by ^{13}C/^{12}C analysis. The corresponding fractionation for ^{14}C can be expected to be twice that of ^{13}C. Contamination of samples is discussed. (BBB)

40868 DISTRIBUTION OF NATURALLY OCCURRING RADIONUCLIDES BELONGING TO THE URANIUM DECAY SERIES. 5. ^{210}Po AND ^{226}Ra CONCENTRATIONS IN DRINKING WATER AND AIR. Kuroda, Takeshi (Tokushima Univ., Japan). Igaku To Seibutsugaku, 76: 34-7(Jan. 10, 1968). (In Japanese).

A series on the effects of environmental factors on the distribution of naturally occurring radionuclides was continued, determining naturally occurring radionuclides concentrations in the water and air of the Miasa uranium mine area, comparing them with the corresponding values in the Okayama City area. About 2,000 to 3,000 ml of water sample was treated with 300 ml of 0.5 N HCl before the analysis. A high-volume air sampler was used to collect the free dust from atmospheric samples, passing 100 to 500 m^3 of air through a glass filter at a flow rate of 1.5 m^3/min to collect free dust which was then dissolved in dilute HCl and filtered prior to analysis. The analytical procedures were described previously. The water samples (water main, well, river, or hot spring water) from the uranium mine area showed a consistently higher natural radionuclide content. The radionuclide content in the air of the uranium-ore processing facility and the offices in the uranium mining town was higher than that of the air in Okayama City. (TTT)

40869 ENVIRONMENTAL POLLUTION AND ITS CONTROL. Eisenbud, Merril (Environmental Protection Administration, New York). Bull. N. Y. Acad. Med., 45: 447-57(May 1969).

Problems of environmental pollution in large cities, including the role of nuclear power plants, are surveyed. Levels of sulfur dioxide, a principal contaminant in the air of cities, should decrease as nuclear power increasingly supplants fossil fuel power generation. The problem of thermal pollution by nuclear power generators is also discussed. Many rivers are about to be used for cooling nuclear power plants, but there is little information with which to deal rationally with the problem of thermal pollution. (BBB) (TSS)

40870 A NOTE OF THE LONG-LIVED ALPHA RADIOACTIVITY OF MINERAL WATERS IN SWIERADOW. Rymaszewska, Maria; Zejmo, Irena (Univ., Warsaw). Acta Geophys. Pol., 17: 39-43(1969). (In Polish).

The long-lived α radioactivity of several mineral waters from Swieradow was examined. The results were compared with the β-activity and the concentration of Rn in the respective waters. (auth)

40871 INFLUENCE OF SOME FACTORS ON THE RADIOACTIVITY OF WATER IN THE SHALLOW RESERVOIR OF THE BARRAGE. Kwapulinski, Jerzy (Wojewodzkie Przeds. Wodociagow i Kanalizacji, Katowice, Poland). Nukleonika, 14: 107-22 (1969). (In Polish).

Monitoring the β-radioactivity of water in a reservoir enabled the maximum and minimum period of β radioactivity to be determined. The highest radioactivity was always observed in the period from spring to summer. The specific β radioactivity of the water in the shallow reservoir was estimated at 6 pCi/dm^3. The specific β-radioactivity was influenced by: the type of wave when collecting samples; the degree of agitation of the water in the reservoir at the given period; the level of water in the reservoir; and the turbidity of water. Lower specific β radioactivity was observed when the water was quiet or when there was a ripple on the surface of the reservoir. A large wave produced a steep rise of the specific β-radioactivity of the water. The agitation of the surface of a reservoir can be described by $K = f(n/m)\ \Sigma_{i=1}^{n} V_i$, where: K—factor characterizing the agitation of the reservoir, n—number of observations when wind was blowing, m—total number observation in the given period, f—factor determining the type of wave when collecting samples, V_i—velocity of the wind when sampling. From this formula it was found that the specific β radioactivity increased with the agitation (K) of the reservoir. It was also observed that a violent rise of the water level in the reservoir may produce the growth of the overall β radioactivity of the water. The dependence of the specific β radioactivity on the turbidity of water was studied in the period 1965 to 1966, but the results obtained were not conclusive. Neither could a correlation be found in the period studied between the specific β radioactivity of water and the total atmospheric precipitation. (auth)

40872 PREDICTION OF CAVITY RADIUS PRODUCED BY AN UNDERGROUND NUCLEAR EXPLOSION. Closmann, P. J. (Shell Development Co., Houston, Tex.). J. Geophys. Res., 74: 3935-9(July 15, 1969).

A correlation has been developed between the cavity produced by a contained underground nuclear explosion and other variables, including explosive yield, overburden density, depth of burial, and the Young's and shear moduli. The relation obtained is $r_{cv} = 21.0W^{0.306}E^{0.514}\rho^{-0.244}\mu^{-0.570}h^{-0.161}$ where r_{cv} is cavity radius in meters, W is yield in kilotons, E and μ are Young's and shear moduli, respectively, in megabars, ρ is overburden density in grams per cubic centimeter, and h is the depth of burial in meters. This equation, based on published results for 46 nuclear events, calculates cavity radius for these events with an average error of 7.8%. Some predictions by this method compare reasonably well with those by other methods for media for which there is no previous experience. (auth)

40873 SPONTANEOUS FISSION TRACKS OF ^{238}U AS A MEANS OF DATING APATITES AND A CONTRIBUTION TO THE GEOCHRONOLOGY OF THE ODENWALD. Wagner, G. A. Neues Jahrb. Mineral., Abh., 110: 252-86(1969). (In German).

The ^{238}U fission track method was used for the first time to date a large number of apatite samples. The method was applicable even to extremely small apatite crystals. The etched fission tracks were best observable on the (0001) face. The stability of fission tracks at increased temperatures was studied by heating samples. Over 10^6 yr, fission tracks in apatite were stable only below 100°C. Results obtained on apatites from various rocks from the Odenwald (Germany) required individual interpretations. Uranium fission track ages obtained on volcanic apatites of the Katzenbuckel represented crystallization ages (60 ± 9 Myr). Fission track ages of apatites from the Odenwald basement varied from 70 to 76 Myr in the southern part to 85 to 105 Myr in the northern part. These ages defined the time at which the corresponding parts of the basement were lifted above a level at which the temperature dropped below ~100°C. Experiments with neutron irradiation and analysis of U in the samples are also reported. (BBB)

Meteorology

Refer also to abstracts 40868, 40911, 40969, 40972, and 41314.

40874 (AD-682732) 1968 SUMMARY REPORT [ON] ENVIRONMENTAL RADIATION MONITORING PROGRAM, MH-1A NUCLEAR POWER PLANT, FORT DAVIS, CANAL ZONE. Clements, Lynn C.; Stricklin, Herbert L. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). Feb. 20, 1969. 17p. (ED-6903). CFSTI.

Tables of the environmental radiation monitoring data collected from October to December 1968 and comparisons with preoperational data collected from August to October 1968 are presented. The results showed that the effects of operation of the MH-1A Nuclear Power Plant on the radiological background are inconsequential. (auth) (USGRDR)

40875 (BNWL-tr-34) DISTRIBUTION, ATMOSPHERIC TRANSFER, AND BALANCE OF ^{85}Kr. Pannetier, Raymond (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report CEA-R-3591. 153p. Dep. CFSTI.

Thesis.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 15973.

40876 (IDO-12071, pp 35-8) AIR RESOURCES LABORATORIES FIELD RESEARCH OFFICE, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

Operational meteorological services at NRTS are reported under the following headings: radar-tetroon transponder system, mesoscale turbulence and diffusion studies, time series analysis of turbulence data, hemispheric dispersion study, deposition and depletion studies, field diffusion measurements over extended periods and downwind distances, and diffusion research model for LOFT support studies. (R.C.K.)

40877 (KURRI-TR-54) DIFFUSION CLIMATOLOGY OF RESEARCH REACTOR INSTITUTE, KYOTO UNIVERSITY. (Kyoto Univ. (Japan). Research Reactor Inst.). [1968]. 21p. (In Japanese and English). Dep.

The Kyoto University Reactor (KUR) at the Research Reactor Institute, Kyoto University has been improved so that its heat rating has been raised from one to five megawatts. Prior to this improvement, the diffusion climatology of the KUR site was investigated as a part of the safety analysis of KUR. Annual percentage frequencies of wind direction are 13% for S, 9% for WNW and NW, 8% for ENE and SSW, and 6% for E. The sum of the six winds amounts to more than 50% of a year. WNW and NW winds mainly occur in the daytime and E, S, and SSW mainly in the nighttime. Harmonic means of wind speed are 3.3 miles/sec for WNW, 2.8 miles/sec for NW, 2.0 miles/sec for SSW, 1.8 miles/sec for ENE, 1.7 miles/sec for E, and 1.6 miles/sec for S. Marked persistence of a certain wind direction seems to occur only in the WNW or NW wind during the period of intense monsoonal outbreak in winter season and ENE or NE wind when a front lies stationary along the Pacific coast of Japan or a tropical cyclone moves slowly over the western Pacific Ocean off the southern coast of Shikoku or Kyushu. (auth)

40878 (PNE-G-46) OFF-SITE RADIOLOGICAL SURVEILLANCE PROGRAM FOR PROJECT GASBUGGY. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). June 1969. 26p. Dep. CFSTI.

Project Gasbuggy, an experiment to stimulate gas recovery by nuclear means, was conducted on December 10, 1967, as part of the USAEC Plowshare Program. The procedures used by the U. S. PHS, which is responsible for the comprehensive Off-Site Radiological Safety Program, and the data obtained in connection with this Project are summarized. Surveillance of the El Paso natural gas producing wells near the Gasbuggy experiment was conducted to ensure that radioactive contaminated gas is not present. (auth)

40879 (UCRL-Trans-10359) STUDIES ON FALLOUT PARTICLES. IV. Mamuro, Tetsuo; Fujita, Akira; Matsunami, Tadao. Translated by J. Byron for Univ. of California, Lawrence Radiation Lab., Livermore, from Nippon Genshiryoku Gakkaishi, 7: 485-92(1965). 17p. Dep. CFSTI.

In NSA, 20: 535.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 535.

40880 (UCRL-Trans-10360) STUDIES ON FALLOUT PARTICLES. VI. Mamuro, Tetsuo; Fujita, Akira; Matsunami, Tadao; Shirai, Shogo; Murakami, Masahito. Translated by J. Byron for Univ. of California, Lawrence Radiation Lab., Livermore, from Nippon Genshiryoku Gakkaishi, 8: 309-16(1966). 16p. Dep. CFSTI.

In NSA, 20: 33529.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 33529.

40881 THE INDUCED RADIOACTIVITY OF THE ATMOSPHERE IN THE PERIOD OF 1966-1968. Behounek, Frantisek (Technische Univ., Prague); Matouskova, J. Jad. Energ., 15: 145-8(May 1969). (In Czech).

Measurements on artificial radioactivity in the atmosphere by the total beta activity method at the radiologic dosimetry station of the Czechoslovak Academy of Sciences indicated a regular increase of radioactivity in the first half-year compared with the second half-year. In the spring, the increase is explained by the seasonal exchange of the stratospheric atmosphere containing fission products from the older nuclear tests and of the tropospheric atmosphere. The presence of fresh short-lived radionuclides ^{95}Zr + ^{95}Nb has been proved in the samples of higher activity by the gamma spectrometric method. The atmospheric nuclear tests in China have been the origin of these radionuclides, and the underground tests in the USA and USSSR often contributed to the release of gaseous radionuclides in the atmosphere. Radioactive contamination of the surroundings of nuclear installations in normal reactor operation is also a factor. (auth)

40882 THE POSSIBILITY OF DETECTING FRESH FISSION PRODUCTS IN THE ATMOSPHERE BY THE AUTORADIOGRAPHIC METHOD. Picer, M.; Pedikovic, D. (Inst. of Medical Research and Industrial Hygiene, Zagreb). Arh. Hig. Rada Toksikol., 19: 559-65(1968). (In Serbo Croatian).

Following the explosion of a nuclear device in China on June 17, 1967, autoradiographic measurements of the total beta activity in the air were carried out from June 25 to July 25 at Gevgelija, Sarajevo, Skopje, Ljubljana, Aidovscina, and Zadar. Furthermore, a count of radioactive particles was made at Zadar. Surface air in an amount of 30 to 1000 m^3 was pumped during 8 to 24 hrs through a filter, then one of several types of film that were found suitable was exposed to the action of the filter containing the radioactive particles. Maxima of beta activity were observed between July 5 and July 15 in the towns mentioned. The highest activity measured was 0.47 pC/m^3 at Skopje on July 14. The results showed that the autoradiographic method is suitable for the detection of radioactive fission particles in the atmosphere following nuclear explosions. (JPRS)

40883 THE INFLUENCE OF FOG ON RADIOACTIVE CONTAMINATION IN THE BIOSPHERE. Marquardt, W. Z. Meteorol., 20: 37-42(1968). (In German).

Of all the meteorological parameters that influence radioactive contamination of the biosphere, fog exerts a particularly strong effect. Air activity in middle mountain stations can be reduced by a factor of 2 or 3 in fog; however, fog water is especially radioactive, having 10 to 15 times the radiation intensity of normal rain water. Small fog droplets act to bind all air impurities to a great extent; radioactive aerosols act as condensation nuclei. These droplets condense in depressions of all kinds, producing a partial decontamination of the atmosphere. The action is greatest at the beginning of a fog and decreases logarithmically with the duration of the fog. The washing out increases with increasing wind velocity and is therefore higher on the Brocken than on the Inselsberg in the middle mountain range. In the flatland, where strong wind and simultaneous fog are uncommon, decontamination by fog is only very slight. (BBB)

40884 REGULARITIES OF THE DISTRIBUTION OF RADON DECAY PRODUCTS ACCORDING TO THE ATMOSPHERE ALTITUDE AND THE MAGNITUDE OF VERTICAL TURBULENT DIFFUSION. Styro, B. I.; Chkhenkeli, Sh. M.; Tavartkiladze, K. A.; Khundzhua, T. G. (Inst. of Geophysics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 54: 321-4(May 1969). (In Russian).

The vertical turbulent diffusion coefficient k_z was determined by studying (with the aid of a special aircraft) the vertical profiles of natural radioactivity caused by short-lived radon series for the middle of the entire lower troposphere and its separate layers. (tr-auth)

40885 OBSERVED VALUES OF THE RADIOACTIVITIES IN ATMOSPHERIC FALLOUT. Taiki Hoshano Kansoku Seiseki, No. 51, 63p(Mar. 1968). (In Japanese).

Data on atmospheric radioactivities observed from Oct. to Dec., 1967 at 13 observations throughout Japan are tabulated under the following categories: measurements of temporary standard sample (U_3O_8) at each station; summary of mean radioactivity in rain collected at fixed time daily; observed radioactivity in rain collected at fixed time daily; and observed radioactivities in airborne dusts collected by the dust collector. (NSA of Japan)

Mineralogy and Exploration

Refer also to abstracts 41573, 41761, and 42000.

40886 (CONF-681064-1) URANIUM SUPPLY AND DEMAND SITUATION. Lloyd, Barry C. J. (Rio Tinto Zinc Corp., London (England)). [1968]. 8p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

Forecasts of future demands for uranium ores are delineated. Reasonably assured uranium ore reserves are predicted for expectations from the Non-Communist countries. Exploration discoveries and results are discussed and projected prices for the 1970's are given. (J.C.W.)

40887 (NP-17982) ANNUAL REPORT, 1968. (National Inst. for Metallurgy, Johannesburg (South Africa)). 22p. Dep.

A review of 1968 activities is presented. It is noted that inauguration of two university research groups into association with the National Institute during the year is important because of their interest in mineral processing problems. Information is also presented on development of ferrochrome production programs, methods for determining platinum metals, nickel separation methods, evaluation methods for fluorospar, determination of mercury, prospecting for pegmatites, determination of rare earths, and prospecting for phosphates. Research on uranium and thorium compounds is reviewed and development of methods for UF_6 production is discussed along with methods for UO_2 and Au separation. (J.R.D.)

40888 U-Th-Pb AGES OF SPHENE AND ZIRCON FROM THE HIDA METAMORPHIC TERRAIN, JAPAN. Ishizaka, Kyoichi; Yamaguchi, Masaru (Carnegie Institution of Washington, Washington, D. C.). Earth Planet. Sci. Lett., 6: 179-85(June 1969).

Four sphenes as well as six zircons, three of which coexist with sphene, from the igneous and metamorphic rocks of the Hida metamorphic terrain, Japan, were analyzed for U-Th-Pb ages. The sphene and zircon U-Th-Pb ages generally agree with each other at about 240 My. This suggests that the Hida metamorphic terrain was regionally metamorphosed about 240 My ago, while the igneous activity represented by The Funatsu granite and uplifting of the terrain took place about 180 My ago all over the metamorphic region. Although K-Ar and Rb-Sr ages of biotite were lowered to 180 My as a result of this igneous activity and uplifting, U-Th-Pb ages of sphene and zircon were not affected strongly and retained the age of the metamorphism. This result may indicate the use of sphene as a suitable mineral for establishing the time of the metamorphism, even if it is relatively young. (auth)

40889 GEOCHEMISTRY OF URANIUM IN THE ZONE OF HYPERGENESIS AND FORMATION OF URANIUM DEPOSITS. Perel'man, A. I.; Batulin, S. G.; Danchev, V. I.; (and others). pp 175-90 of Problemy Geologii Mineral'nykh Mestorozhdenii Petrologii i Mineralogii. Tom I. Chukhrov, F. V. (ed.). Moscow, Izdatel'stvo Nauka, 1969. (In Russian).

Hypergenic uranium migration in oxidation media and inertia in a reducing environment are discussed. A large group of deposits revealed characteristic beds of epigenic zones with uranium ore depositions. Formation of exogenic and epigenic uranium deposits and the basic epigenic theory are analyzed. (R.V.J.)

40890 PROBLEMY GEOLOGII MINERAL'NYKH MESTOROZHDENII PETROLOGII I MINERALOGII. TOM I. PROBLEMY GENEZISA I LOKALIZATSII MINERAL'NYKH MESTOROZHDENII. (Problems of Geology of Mineral Deposits, Petrology, and Mineralogy. Vol. I. Problems of Genesis and Localization in Mineral Deposits). Chukhrov, F. V. (ed.). Moscow, Izdatel'stvo Nauka, 1969. 283p.

Sixteen articles are included on the theory of endogenic and metallogenic ore formation. A separate abstract was prepared for each of two articles. The remaining articles include general information on depth tectonics, distribution of ore deposits, localization of hydrothermal deposits, and theory of metasomatic ore deposit formations not within scope of NSA. (R.V.J.)

40891 GEOLOGICAL CONDITIONS OF FORMATION OF URANIUM AND URANIUM-THORIUM DEPOSITS. Belova, L. N.; Vol'fson, F. I.; Kazanskii, V. I.; (and others). pp 150-74 of Problemy Geologii Mineral'nykh Mestorozhdenii Petrologii i Mineralogii. Tom I. Chukhrov, F. V. (ed.). Moscow, Izdatel'stvo Nauka, 1969. (In Russian).

The formation of uranium and uranium-thorium deposits and regularities of their distribution are briefly discussed. Peculiarities of their magnetism, metasomatic processes taxing place during deposition of radioactive minerals and paragenic association of these minerals are examined. Formation of uranium-phosphorus deposits and deposits of uranium in carbonaceous-argillaceous and carbonaceous-siliceous shist environments are analyzed as well as the oxidation of uranium deposits and their causes. (R.V.J.)

40892 URANIUM ORE DEPOSIT AT MARY KATHLEEN. Hughes, F. E.; Munro, D. L. pp 45-56 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16-21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.

See CONF-680654.

A new interpretation of the Mary Kathleen deposit near Cloncurry, North Queensland, is given based on a revised structural interpretation, detailed mapping during mining, and a reexamination of diamond drill cores. The host rocks are folded and faulted Lower Proterozoic sediments. The structural setting of the orebody is an axial zone of a folded structure. A calc-silicate formation has undergone medium-grade regional metamorphism. The mineralization is regarded as epigenetic, related to contact metasomatism from late phase emanations from a granite. The host rock of the uranium mineralization is a very garnet rich part of a breccia-conglomerate. Host minerals for the uranium mineralization are allanite, stillwellite, a lanthanum boro-silicate, and apatite. Uraninite is disseminated as irregularly ovoidal grains of 0.1 to 0.01 mm diameter. The major sulphide, pyrrhotite, and pyrite, marcasite and chalcopyrite, are later in the sequence. One age determination is given (1640 × 10^6y). The distribution of the mineralization is pictured as irregular honeycombs of connected shoots separated by waste. Ore shoots vary in width from a few to 150 feet. Irregular uranium occurrence dictated highly selective mining of open cut with close geological supervision. Production to December 1962 was 7,429,523 lb U_3O_8. Reserves at March 1968 were 2.87 × 10^6 tons with 3.26 lb U_3O_8/ton. (Australia)

40893 ORIGIN AND CONTROLS OF URANIUM MINERALIZATION IN THE SOUTH ALLIGATOR VALLEY. Taylor, J. pp

32-44 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.
See CONF-680654.

Deposition of uranium in the South Alligator River area has been influenced structurally by reverse faulting and lithologically by carbonaceous shales and sandstones. Mineral assemblages suggest a mesothermal-epithermal epigenetic mode of origin. The ultimate source of the uranium and associated metals is probably in deep seated magnetism which is expressed at surface in the widespread penecontemporaneous volcanity. (auth) (Australia)

40894 THE GEOLOGY OF THE RUM JUNGLE URANIUM DEPOSITS. Berkman, D. A. pp 12-31 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.
See CONF-680654.

Three major and two minor uranium deposits have been worked by open cut mining since the discovery of the Rum Jungle field in 1949. Total production has been about 967,000 tons of uranium ore at 7.39 lb U_3O_8/ton and 402,000 tons of copper–uranium ore at 6.27 lb U_3O_8/ton and 2.7% Cu, with significant tonnages of base metal ores. The deposits occur in or near black pyritic slates of the lower Proterozoic Golden Dyke Formation, near the contact with the underlying Coomalie Dolomite. The mineralization is probably younger than the granite complexes in the area, and a structural-stratigraphic control of ore deposition is used as a basis for uranium exploration. (auth) (Australia)

40895 SYMPOSIUM ON URANIUM IN AUSTRALIA, HELD AT RUM JUNGLE, NORTHERN TERRITORY, AUSTRALIA, JUNE 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968. 186p. (CONF-680654).

Nine articles are included; an abstract was prepared for each. (P.C.H.)

For abstracts of individual papers see: 40825–40827, 40892–40894, 40896, 41021, and 41713.

40896 MINING PRACTICE IN THE SOUTH ALLIGATOR VALLEY. Fisher, W. J. pp 57-89 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.
See CONF-680654.

Mining practice in the South Alligator Valley between 1954 and 1964 is described. The valley is situated in the Northern Territory 130 miles south east of Darwin and trends north west. The centrally located El Sherana camp is 219 miles by road from Darwin via Pine Creek on the Stuart Highway. Sixty-four miles of gravelled road with low level bridges and culverts which were completed in 1959, connect Pine Creek with El Sherana. This road is often impassable during severe wet season conditions. Earliest recorded production was during the years 1956 to 1957 from the El Sherana and Palette mines, by shallow open cut and cut and fill stoping from small shafts. 4600 tons of high grade ore was processed by hand sorting of massive pitchblende followed by gravity concentration. At the same time 627 tons of ore was won from a small open cut at Sliesbeck 35 miles SE of El Sherana. The second and most important phase of production was to fill two small contracts with the United Kingdom Atomic Energy Authority (U.K.A.E.A.) totalling 700 tons of U_3O_8. About 144,000 tons of ore was mined from widely separated small orebodies and mining practice varied from small open stoping and cut and fill stoping. In some orebodies a combination of several methods was employed to complete production. Final deliveries were made to the U.K.A.E.A. in 1964. (auth) (Australia)

40897 GEOCHEMICAL SURVEY OF THE TOSCANA REGION FOR URANIUM PROSPECTING. Dall'Aglio, M.; Giannotti, G. P. (CNEN, Rome). Atti Soc. Toscana Sci. Natur. Pisa, Proc. Verb. Mem., Ser. A, 75: 125-45(1968). (In Italian). (RT/GEO(68)17).

Results and data dealing with a regional geochemical survey, for uranium prospecting carried out in Tuscany region (central Italy), are discussed. About 1,000 surface water samples and 1,000 of alluvial samples were collected and analyzed. For each surface water sample, besides the uranium content, values of: pH, electrical conductance, contents of major elements dissolved, were determined. The alluvial samples were analyzed for the uranium content only. Accordingly, with the geological and lithological features of the region, which are not favorable as economic uranium-bearing deposits, only some weakly anomalous areas in uranium content were localized. These anomalies are connected probably either with lithological features and/or with particular geochemical environments. (auth)

Oceanography

40898 THE DISTRIBUTION OF URANIUM IN RECENT CARBONATE SEDIMENTS AND SKELETONS OF ORGANISMS AND THE EFFECT OF DIAGENESIS ON URANIUM REDISTRIBUTION. Haglund, David S. Troy, N. Y., Rensselaer Polytechnic Inst., 1968. 156p.
Thesis.

A study of the uranium concentrations of calcium carbonate skeletons from Recent molluscs, corals, algae, hydrozoans, and a barnacle and unconsolidated skeletal sands was undertaken to establish relations between environmental, mineralogical, and taxonomic control of uranium uptake. In addition, two suites of carbonate sediments each composed of Recent unconsolidated marine beach sands and consolidated Pleistocene limestones were examined to establish the effect of fresh water alteration on the uranium content. Analytical work included uranium analyses by the fission track powder method and quantitative mineralogy by x-ray diffraction techniques. Environmental designations of the samples were made on the basis of geomorphology. (TSS) (Diss. Abstr.)

40899 STATE OF ULTRASMALL QUANTITIES OF ^{144}Ce AND ^{91}Y IN SEA WATER. Spitsyn, Vikt. I.; Bernovskaya, R. N.; Popov, N. I. Dokl. Akad. Nauk SSSR, 185: 111-14(Mar. 1, 1969). (In Russian).

The transformations of ionic forms of ^{144}Ce and ^{91}Y, which were introduced into seawater taken from different depths of the Pacific Ocean, were followed in order to determine the migration ability of the rare earth elements. The behavior of ^{144}Ce and ^{91}Y in turbid waters obtained from the surface layer of bottom deposits at a depth of 5173 m was investigated to determine the complexing effect of dissolved organic matter. A suspended state and a "dissolved" state of the radionuclides were differentiated by filtration through an ultrafine membrane (pore size of 0.1 microns). All water was filtered through this membrane filter before introduction of the radioisotope in a small amount of 0.1 N HCl. The amount of radioactivity retained by the filter was <10% at a pH of 4.0 or lower, and increased to about 40% at a pH of 6.0 and higher. The possibility of true colloid formation with phosphate ions is not excluded (<0.1 microns in size). The rare earth ions may also be present in dissolved form as complexes. The content of suspended ^{91}Y goes through a minimum in seawater taken at depths of 100 and 500 m, where the ^{91}Y is completely soluble for all practical purposes. A differentiation between ^{144}Ce and ^{91}Y takes place in seawater with ^{144}Ce reporting preferentially to the precipitate and ^{91}Y remaining in solution. (TTT)

Seismology

Refer also to abstract 40856.

40900 (AEC-tr-7075) REPORT ON DAMAGE DUE TO NIIGATA EARTHQUAKE. (Tohoku Electric Power Co. Ltd., Sendai (Japan)). [Translated from selected Japanese papers]. 44p. Dep. CFSTI.

The damage caused by the Niigata earthquake is reviewed with particular emphasis on damage to electric power generating and distributing equipment and to civil engineering structures. Localized sandy soil conditions in Niigata City are considered the main factor which contributed to damage in excess of that experienced in nearby areas. (L.C.L.)

40901 (NVO-1163-175) AMPLIFICATION OF RAYLEIGH WAVES IN A SURFACE LAYER OF VARIABLE THICKNESS. Murphy, J. R.; Davis, A. H. (Environmental Research Corp., Alexandria, Va.). Feb. 4, 1969. Contract AT(29-2)-1163. 50p. Dep. CFSTI.

A method of calculating the relative amplitudes of Rayleigh waves as a function of frequency at two observation points located on surface layers with differing thickness or physical properties is presented. The analytic approach centers on a solution of the boundary value problem which allows the amplitude as a function of depth to be written in terms of a single unknown; the free surface amplitude. The energy flux is assumed to be equal at the two horizontal positions of interest, and the ratio of the free surface amplitudes at the two locations can be computed as a function of frequency. A computer program which has been written to compute these amplitude ratios is described and a series of theoretical amplification curves are presented for models considered to be representative of the geology in and around the Nevada Test Site. Recommendations are made that the analytic model presented in this report be tested empirically using data from the Las Vegas valley instrumentation line. (auth)

40902 (SC-M-69-403) UNATTENDED SEISMOLOGICAL OBSERVATORY (DEVELOPMENT REPORT). (Sandia Labs., Albuquerque, N. Mex.). June 1969. 135p. Dep. CFSTI.

Three seismological observatories were designed to operate unattended for periods up to 120 days and were installed near Fairbanks, Alaska, at the Uinta Basin Seismic Observatory, near Vernal, Utah, and on Sandia Base, Albuquerque, New Mexico. Design of the Unattended Seismological Observatories, installation procedures, and a preliminary approach for tamperproofing the system are presented. (auth)

40903 THEORETICAL RESPONSE OF A SEISMOGRAPH AT YELLOWKNIFE, NORTHWEST TERRITORIES, TO AN UNDERGROUND EXPLOSION AT THE NEVADA TEST SITE. Hasegawa, H. S.; Whitham, K. (Dominion Observatory, Ottawa). Can. J. Earth Sci., 6: 517-20(June 1969).

A comparison of the theoretical response of the short-period, vertical-component seismograph at Yellowknife to an underground explosion originating at the Nevada Test Site (N.T.S.) with a real seismogram indicates that the prime contributors to complexity are likely due to complex crustal reverberations at the N.T.S., different phase arrivals, and signal-generated noise at Yellowknife. (auth) (Canada)

40904 EARTHQUAKES ASSOCIATED WITH UNDERGROUND NUCLEAR EXPLOSIONS. Boucher, Gary; Ryall, Alan; Jones, Austin E. (Univ. of Nevada, Reno). J. Geophys. Res., 74: 3808-20(July 15, 1969).

Grossly observable effects of underground nuclear tests on regional seismicity are presented. Most of the data were obtained at the Tonopah station, 100 to 150 km from the explosions studied. Periods of time before and after 21 explosions were examined. In all cases of explosives with magnitude $m_b \geq 5.0$, an increase in seismicity was observed for at least one day following the test. The decay of post-shot activity and its relationships to the equivalent magnitude of the explosion provide confirmation of the determination role of the nuclear event. For the most part, this activity was confined to the test site, and was probably located within 20 km of the shotpoint. In one case, however, earthquake activity following the Faultless test in January 1968 may have extended to 40 km from the site of the explosion. One or two of the earlier tests studied may have influenced seismicity at larger distances. Most of the events studied had very small magnitudes, and all earthquakes related to underground tests had magnitudes lower, by at least one magnitude unit, than those of the associated blasts. Attempts to determine the extent to which underground tests influence seismicity in active areas distant from the test site indicated that, if such effects exist, they are probably minor compared with normal variations in seismicity. (auth)

40905 IDENTIFICATION OF EARTHQUAKES AND EXPLOSIONS BY USE OF TELESEISMIC DATA. Evernden, J. F. (Nuclear Monitoring Office, Washington, D. C.). J. Geophys. Res., 74: 3828-56(July 15, 1969).

Criteria for achieving an order of magnitude discrimination between underground explosions and shallow-focus continental earthquakes are presented. The basis of all these criteria was the gross difference between earthquakes and explosions as regards their relative generation of short- and long-period waves. It was also found that depth of focus of small events can be accurately determined either by use of master-controlled travel-time corrections or by determination of time of origin (Pg, S-P, etc.). Therefore, the basic problem for differentiating earthquakes and underground explosions of magnitude $4\frac{3}{4}$ or greater by seismic criteria has been solved. The remaining problems are the detection of long-period waves at low signal-to-noise ratios and the evaluation of the applicability of long-period identification criteria for low-magnitude events. (auth)

40906 SEISMIC ACTION OF POWERFUL EXPLOSIONS. Shamin, V. M. (Inst. of Earth Physics, Moscow). Dokl. Akad. Nauk SSSR, 185: 1280-1(Apr. 21, 1969). (In Russian).

The critical velocity due to oscillations of the earth that cause damage in the form of cracks to brick buildings was taken to be 10 cm/sec. However with large explosions the mechanism of seismic action must also change. The first sign of such a change was the large number of complaints of damage after exploding a 5 kt nuclear bomb at a depth of 825 m in the United States. A total of 200 complaints were received in a town 36 km from the epicenter of the blast, where the velocity of the oscillations was 0.5 cm/sec, but the duration of the oscillations was as long as 90 sec. An analysis of the general picture of seismic oscillations shows that secondary waves which have been reflected a number of times are distinguished by a long time of oscillation, and can cause damage at lower surface velocities of the oscillations. The maximum displacement is proportional to the product of the initial amplitude of the wave and duration of the oscillation. Hence the value of the critical velocity of 10 cm/sec, established earlier for rapidly damped oscillations of the ground, should be lowered considerably on increasing the duration of the oscillations. (TTT)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 40872, 40878, 40903, 40906, 40997, and 41762.

40907 (JPRS-48338) PROSPECTS OF USING NUCLEAR EXPLOSIONS IN DEVELOPING OIL AND GAS DEPOSITS. Mangushev, K. I.; Zolotovitskaya, E. A. Translated from Geol. Nefti Gaza, 13: No. 4, 20-4(1969). 10p. CFSTI.

The prospects of using underground nuclear explosions for stimulating oil and natural gas production, the seismic and radiological safety of the procedures, and the economic and technical feasibility for particular geologic circumstances are presented. It is concluded that underground nuclear explosions would be particularly advantageous due to the geologic characteristics of many of the gas and oil deposits in the USSR. (L.C.L.)

40908 (UCRL-50693) PUBLIC CORPORATION FOR PLOWSHARE. May, Michael M. (California Univ., Livermore. Lawrence Radiation Lab.). June 24, 1969. 9p. Dep. CFSTI.

The industrial utilization of nuclear explosives is being seriously contemplated by both private concerns and governments. One way to meet the problems which will arise in such utilization is by establishing a government-sponsored, publicly owned corporation. Some of the advantages and disadvantages of such a corporation are discussed. (auth)

40909 PEACEFUL APPLICATIONS OF NUCLEAR EXPLOSIVES. di Loreto, Angelo. Ing. Nucl., 9: No. 4, 9-18(July-Aug. 1968). (In Italian).

A release from the Information Office of the United States Ambassador to Rome on the peaceful application of nuclear explosives is presented. Information is given on the Gnome project, the Sedan project, the future of the Plowshare program, the opening of a new Atlantic-Pacific canal, recovery of petroleum, and future projects for nuclear explosives. (J.S.R.)

40910 THE PEACEFUL USE OF NUCLEAR ENERGY EXCEPT OF ELECTRIC POWER PRODUCTION. Eklund, Sigvard (International Atomic Energy Agency, Vienna). Tek. Tidskr., 99: 427-30(1969). (In Swedish).

Uses of nuclear energy for purposes other than production of electricity are reviewed. The costs of conventional explosives and nuclear explosives are compared. The uses of nuclear energy in civil engineering e.g., building dams, canals and harbors, in mining engineering to liberate gas, oil and minerals, for desalination of sea water, and in agriculture and food technology are discussed. The concept of "energy center" is mentioned. (Sweden)

40911 ESTIMATION OF THE ELAPSED TIME AFTER NUCLEAR EXPLOSION BY MEASURING ACTIVITY RATIO OF ^{95}Zr AND ^{95}Nb IN THE RADIOACTIVE FALLOUT. Fujii, I.; Onodera, K. (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Inorg. Nucl. Chem., 31: 1907-14(July 1969).

A method for estimation of the elapsed time after nuclear explosion from a given radioactive fallout was developed wherein activities of ^{95}Zr and ^{95}Nb belonging to the same decay chain in fission products are measured by the Ge(Li) gamma detector, and the elapsed time is calculated from their activity ratio. The experimental results obtained from a neutron irradiated uranium sample and from radioactive fallout which had been found in Nagano City, Japan, after the nuclear explosion experiment in China, were in good agreement with theoretical values. The method can be applied to estimation of history or origin on a given fallout. (auth) (UK)

Facilities and Equipment

Refer also to abstracts 40963, 40965, 40968, 40973, 40978, 41413, 42152, 42159, 42217, 42792, 42815, and 42817.

40912 (AERE-M-2117) A GUIDE TO THE IRRADIATION OF MATERIALS IN THE REACTORS DIDO AND PLUTO. 1969 Edition. Bromley, J. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 48p. Dep. CFSTI (U. S. Sales Only). UK 7s. 0d.

Some of the more common substances which may be safely irradiated in the routine irradiation rigs in DIDO and PLUTO are listed. Details of the safety criteria which have been used in drawing up the lists are also given. It is hoped that this information will provide a useful guide to enable decisions to be reached on the safety of irradiations which have not so far been considered. Typical examples of unusual irradiations which have been performed by special arrangements are included. (auth) (UK)

40913 (BNL-50149, pp 123-52) ENGINEERING DIVISION. Sheehan, T. V. (Brookhaven National Lab., Upton, N. Y.).

Research on heat transfer revealed that displacement of a heater rod in a bundle from its symmetrical position can result in a large reduction of the bundles average heat transfer coefficient. Other research findings are reported on incipient-boiling superheat in alkali metals, heat transfer in laminar flow thermal-entry-regions, turbulent entrance-region heat transfer to liquid metals, development of induction heating equipment for liquid metals, and liquid metal void probe development. Waste disposal study results are summarized. Development of an improved Pt crucible is reported and work toward a waste melter is discussed. Progress is reported on a process for separating Kr and Xe from fuel processing off gases. Efforts toward reactor safety are reported in studies on chemistry of fission products, behavior of aerosols, and fission product release from fast reactor fuels. Work on the reference design of pulsed reactors is reported. (J.R.D.)

40914 (CONF-690116-1) UNCONVENTIONAL THERMAL, MECHANICAL, AND NUCLEAR LOW-POLLUTION-POTENTIAL POWER SOURCES FOR URBAN VEHICLES. Hoess, Joseph A.; Stahman, Ralph C. (Society of Automotive Engineers, Inc., New York). [1969]. 22p.

From International Automotive Engineering Congress, Detroit, Mich.

A wide scope of unconventional thermal, mechanical, and nuclear systems and devices is reviewed to determine which, if any, might be suitable within the next 10 years for application as low-pollution-potential power sources for urban vehicles, and which of those found suitable are most promising for such application. It is concluded that of the many types of unconventional non-electrochemical power sources that are even conceptually possible as vehicle drives, only three appear to offer the near-future possibility of supplanting the I.C. engine in many urban automotive applications; Rankine-cycle engines (which includes steam), gas turbines, and Stirling-cycle engines. For general urban automotive application, the Rankine-cycle class, followed closely by the gas turbine appears to be the most competitive. All of the more exotic types of systems (direct thermal-electric converters, pure mechanical and thermal energy storage, and nuclear systems) will continue to be too big, too heavy, and too expensive to be competitive. (auth)

40915 (EUR-4264) CAN THORIUM COMPETE WITH URANIUM? AN ASSESSMENT FOR HEAVY-WATER AND GRAPHITE MODERATED REACTORS. Graziani, G.; Rinaldini, C.; Zanantoni, C.; Devos, J. J.; Paruccini, M. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 14, 1969. 70p. Dep.

The cost of thorium fuel cycles with fully enriched uranium make-up and of natural and enriched uranium fuel cycles was investigated for D_2O moderated pressure tube and pressure vessel reactors and high temperature gas-cooled reactors. The fuel cycle cost was optimized by a parametric investigation of burn-up, specific power, and moderation ratio. A continuous charge-discharge fuelling was assumed with full recycle, and partial and segration schemes. The comparison between the fuel cycle cost of the uranium and thorium cycle shows a slight advantage for thorium under present economic conditions. The economic conditions, which should be realized in order to make thorium more competitive, are investigated by means of a parametric survey of the cost of fabrication, reprocessing, ore processing and separative work. (auth)

40916 (NP-17975) ANALYSIS OF TURBINE MISSILES RESULTING FROM LAST-STAGE WHEEL FAILURE. Zwicky, E. E. Jr. (General Electric Co., Schenectady, N. Y. Large Steam Turbine-Generator Dept.). Oct. 3, 1967. 73p. (TR-67-SL-211). Dep. CFSTI.

For General Electric Co., Atomic Power Equipment Dept., San Jose, Calif.

Calculations made to evaluate the potential damage which could be done by hypothetical turbine missiles in the event of the failure of the last-stage wheel of a nuclear machine are described. It is concluded that the missile kinetic energy absorbed by the turbine casing is as large or larger than previously assumed, and that a 120° wheel fragment is potentially more damaging then either a 90° or 180° fragment. The potential damage increases slightly with last-stage wheel size. The concrete slab thicknesses penetrated for the 38, 43 and 52" wheels are in the approximate ratios (1): (1.01): (1.08). (auth)

40917 (NP-17983) CONVERSION OF A CONVENTIONAL HORIZONTAL PRESS FOR HYDROSTATIC EXTRUSION. Donaldson, C. J. H. (National Engineering Lab., Glasgow (Scotland)). Mar. 1967. 18p. (NEL-279). Dep.

A conventional horizontal cordite extrusion press has been converted for hydrostatic extrusion. The reasons for the conversion and methods of accomplishing it are discussed. Two different types of high-pressure cylinders and sealing arrangements are examined. The operation of the press for hydrostatic extrusion is described. Preliminary results for the extrusion of aluminum in solid and hollow sections at extrusion ratios of up to 56 and product lengths of from 4 to 21 ft are given. (auth)

40918 (NP-17985) INVESTIGATION OF SPEED INSTABILITY IN HYDROSTATIC EXTRUSION. Low, A. H.; Donaldson, C. J. H. (National Engineering Lab., Glasgow (Scotland)). May 1967. 24p. (NEL-289). Dep.

In hydrostatic extrusion the billet is separated from the extrusion ram by a highly compressed liquid. Thus there is no direct control of extrusion speed and, under certain conditions, instability arises causing intermittent movement of the billet. This effect produces variations in dimensions, surface finish and mechanical properties of the product. A short investigation has been made into the causes of instability, the factors governing this behavior and techniques of controlling it. The effectiveness of the measures taken are discussed and suggestions for further investigations are given based on the results obtained. (auth)

40919 (NYO-3839-6) EXPERIMENTAL INVESTIGATION OF A STEAM-LUBRICATED ROTOR-BEARING SYSTEM: STEAM HAMMER INSTABILITY, DOUBLE-ACTING THRUST BEARING, AND SYSTEM DYNAMIC PERFORMANCE. Malanoski, S. B.; Orcutt, F. K. (Mechanical Technology Inc., Latham, N. Y.). June 1969. Contract AT(30-1)-3839. 91p. (MTI-69-TR-29). Dep. CFSTI.

A continuing investigation aimed at developing design data for the introduction of steam-lubricated bearings into turbomachines is described. The multi-bearing steam-lubricated apparatus includes journal and thrust bearings with auxiliary systems and instrumentation to control the steam supply rates, the rotor-bearing system dynamic performance, and the environmental temperature. Steam hammer stability tests showed that a double-acting thrust bearing was not only more stable than a single-acting thrust bearing, but also that, by using the double acting thrust bearing in the bearing system, the journal bearing showed improved stability characteristics. Environmental temperature had only a slight effect on the steam hammer stability characteristics. Bearing performance was, however, very sensitive to surface conditions in the region of the steam feed hole. Further study aimed at eliminating this sensitivity is recommended. (L.C.L.)

40920 (UNC-5236) PERFORMANCE EVALUATION OF HEAT EXCHANGERS FOR SODIUM-COOLED REACTORS. Final Status Report. Goldmann, K.; Israel, S. L.; Nolan, D. J. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). June 1969. Contract AT(11-1)-1452. 303p. Dep. CFSTI.

Results of evaluation of ALCO and B & W heat exchanger data are presented. The evaluation was carried out to establish the thermal and structural performance of each unit. Design methods are also evaluated. (J.R.D.)

40921 A METHOD OF TEMPERATURE CONTROL IN CAPSULE IRRADIATION. VACUUM CONTROL METHOD. I. Hayashi, Takao; Kudoh, Mitsuo (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 390-401(July 1969).

A method is presented for controlling the temperature of specimens during capsule irradiation. A narrow gas gap layer is provided in the capsule between the outer and inner cans to serve as thermal resistance barrier. The value of thermal resistance is regulated by varying the vacuum pressure in the gas gap from a control device placed outside the reactor. A discussion is given of theoretical analyses made on the characteristics, the effectiveness, and the limits of this temperature control mechanism based on experimental data from mock-up and in-pile experiments, demonstrating the practical utility of the method. The method can be expected to find wide application in other fields also. (auth)

40922 IRRADIATION PLANT. Brunner, Alfred (to Sulzer Brothers Ltd.). U. S. Patent 3,454,761. Priority date Apr. 13, 1964, Switzerland.

A design is given of an irradiation plant with oversized passageways to permit entry for repair work. Doors are provided with the passageways to act as shields and have recesses sized to permit conveyance of goods therethrough with a small clearance. The doors are hinged to move against the walls of the passageways to permit access through the passageways. (Offic. Gaz.)

40923 ON THE POSSIBILITY OF AN ASYNCHRON MACHINE WITH SUPERCONDUCTING CONDUCTION MATERIAL. Kovacs, Karl Paul (Research Inst. for Electric Energy, Budapest). Elektrotech. Z., A, 90: 162-4(Mar. 28, 1969). (In German).

An asynchron machine is described in which superconducting materials are used to achieve a device without important Cu or Fe losses or eddy current in either the stator or the rotor. The machine consists of an asynchronous motor with a three-phase or multiphase symmetric stator arrangement and of a magnetically asymmetric rotor; it may be arranged either with or without short circuit windings. Superconducting materials may be used for the stator interior if the rotor is constructed from monopoles without Fe losses. In a single-axis rotor winding the material for the rotor could be superconducting. It is determined that these models are suitable for the asynchron motor with a single-axis rotor or monopoles without rotor winding but with a condenser in the stator circuit. (BBB)

40924 DEVICE FOR IRRADIATION OF A SODIUM COOLED FUEL SAMPLE CAPSULE. Gerosa, A.; Martini, M. (CERN, Rome). Ing. Nucl., 9: No. 4, 29-37(July-Aug. 1968). (In Italian).

An irradiation device for fuel samples is briefly described. The device consists of a capsule containing sodium or a sodium-potassium alloy; inside the capsule a coaxial cable to the sample to be irradiated divides the inside of the capsule into two zones facilitating the convection motion of the liquid metal; therefore the dissipation of the heat generated in the sample occurs partially by conduction in the radial direction and partially by convection in the axial direction. The capsule, designed for installation in a swimming pool reactor, is cooled externally by water from the pool under forced convection. The design criteria for the capsule and the calculation method used are illustrated. A calculation program in FORTRAN IV, used for a parametric thermohydraulic study of the device, with the purpose of optimizing the characteristics, is described. (tr-auth)

40925 IRRADIATION DEVICE. Kasamatsu, Tomomichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-10359. May 14, 1969. Filed Nov. 14, 1966.

The irradiation device proposed is used for irradiating solids, foods, chemicals, etc. on belt conveyors. The advantages are the elimination of labyrinths, uniform irradiation of the objects, linear movement of the objects on belt conveyors, and high economy in shielding materials. Two long parallel walls of a shielding material are put up with wide space between them. Rows of square pillars of a shielding material are set within the space in a direction parallel to the long walls; this gives the plurality of conveyor or paths between the rows. On the inside of either wall, touching the surface, square pillars of shielding material, similar to the pillars in rows, are set up. The front face of the pillars at the wall sees the narrow space produced between the adjoining pillars in a row; the face of the latter pillars, opposite to the face seeing the wall, faces the space produced between the adjoining pillars in the next row; etc. A radiation source is placed in each space between the adjoining pillars at either wall and also in the each space between the adjoining pillars in each row. Objects for irradiation are passed through the plurality of paths on belt conveyors during irradiation with the respective sources. The radiation from the sources is partially shielded by means of surrounding pillars. (NSA of Japan)

40926 COMPARATIVE REVIEW OF THE ECONOMICAL TRANSPORT OF LARGE SATELLITES FOR DIRECT TELEVISION IN THE 24-HR ORBIT. Oldekop, W.; Rasch, W.; Scharf, W. (Deutsche Forschungsanstalt fuer Luft- and Raumfahrt e. V., Brunswick). Luftfahrttech.-Raumfahrttech., 14: 180-5(July-Aug. 1968). (In German).

The practicality of using nuclear energy as a power source for launching large satellites into 24-hr orbits for television broadcasting is discussed. The technical and economic feasibility of using nuclear power sources for effective emplacement in synchronous orbits is compared in detail with the possible use of solar radiation as an energy source. It was demonstrated that the in-core thermionic reactor system (iTR) was superior to the silicon-n/p cell solar radiation system at outputs above 20 kW because of its greater mass efficiency fraction. In addition, the costs of the solar electrical system in this output range would be considerably higher than with a completely chemical power drive. On the other hand, it was estimated that the nuclear energy power system would provide for considerable savings as compared to the chemical power system. These savings would be of the order of 2.5 million dollars for a 24-hr orbit satellite. (BBB)

40927 CASCADE DISSOLVERS (Nov. 20, 1968) (Engineering Materials). (Dow Chemical Co., Midland, Mich.). (CAPE-1900). 14 drawings.

Cascade dissolvers used in the recovery of recycled Pu from crucible sand, insulation ash, graphite, pulverized glass, slag and sludge are described. (See CAPE-1185). The equipment consists of 5 dissolvers, an R-6 filter, acid and water rotometers, and a vibra-feeder. The dissolvers are limited to 2 kg of Pu each. Steam coils located in the bottom of the dissolvers supply heat and agitation. The first dissolver is equipped with a manually controlled high capacity steam coil to compensate for the cold nitric acid additions. Steam pressure to the other dissolvers is controlled by preset steam pressure. Solids collected on the R-6 filter are dried on a hot plate. The acid and water rates are 1 liter/hr, the feed rate is 200 g/hr, and the pulverized slag CaF_2 rate is 10 g/hr. (For details see TID-4100 Suppl. 54) (F.S.)

40928 AUTOMATIC WELDING DEVICE. Komuro, Kojiro (to Hitachi Ltd.). Japanese Patent 1969-5956. Mar. 4, 1969. Filed Apr. 22, 1966.

The automatic welding device is used for sealing the end of a fuel rod, which is made up by the cladding, nuclear fuel, and helium gas filling the space in the rod. The method eliminates defects in the weld of the fuel rod end and is continuous and automatic. The welding device consists of the following: a welding chamber filled with helium; a fuel rod with cladding whose sealing end is inserted into the chamber horizontally; a welding torch inserted into the chamber vertically at right angles to the direction of the fuel rod; a helium tank connected to the welding chamber and the helium bomb; valves located appropriately for introducing the gas into the chamber from the tank; a means for rotating the fuel rod; and a timer that controls the operations of welding, gas introduction, and fuel rod rotation. First, the fuel rod with cladding is filled with helium gas in the chamber, and the end is closed with a plug; The gas pressures in the cladding tube and the chamber are the same. The fuel rod end is sealed temporarily by the welding torch, and the helium pressure in the chamber is increased by further introducing the gas from the tank. The final, permanent sealing is done with the welding torch. (NSA of Japan)

40929 HEATED TRANSFER TUBES (May 24, 1969) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1902). 12 drawings.

Resistance-heated transfer tubes, used to move liquid metals and molten halide salts in pyrochemical separation processes by pressure-siphoning, are described. The J- or U-shaped tubes are fabricated from gun-drilled Mo-30 wt % W bar stock and shaped by hot-bending in a jig. Joints are prepared using a modified Whitworth fine thread with rounded roots. The coupling is threaded from both ends and terminates in a flat face shoulder. A gasket seal of 0.010 in. thick Ta is placed between the butt end of the tube and the internal shoulder. Joints are sealed and locked by back brazing with a Pd-Ni alloy in an Ar atmosphere. Two types of resistance heaters can be used. A Nichrome heater wire enclosed in a swaged $\frac{1}{8}$ in. OD Inconel jacket insulated with magnesia powder gives good service up to 800°C. A cable fabricated of stranded Chromel heater wire insulated with refractory braid and wrapped in stainless steel winding, produces a flexible moisture proof heater. (For Details see TID-4100 Suppl. 54; see also 23: 29037) (F.S.)

40930 LATCHING DEVICES FOR CLOSURE PLUGS OF TUBES. Pettinger, Donald Stanley (to United Kingdom Atomic Energy Authority). British Patent 1,159,863. July 30, 1969. Filed Mar. 22, 1967.

Reference is made to latching devices for closure plugs of reactor fuel element channels and to grabs for removing these devices from, and replacing them in, the channels. The device described comprises a set of radially extending members for engagement with a groove in fuel channel, whereby it is retained in the channel against internal pressure, and a second set of such members for engagement with an internal groove in a grab. The two sets of latch members are interlinked so that when one set of members is extended the other set is retracted. Means are provided for interchanging the extended and retracted positions of the interlinked sets of latch members. Means are also provided for restraining the latch members from retraction out of groove engagement until movement between the grab and the device has taken place to release interhooked engagement of projections provided on the second set of members and the grab. (UK)

40931 PLAN OF A SUPERCONDUCTING ALTERNATING CURRENT CABLE. Kafka, Wilhelm. Elektrotech. Z., A, 90: 89-92(Feb. 2, 1969). (In German).

The properties of a superconducting ac cable are calculated and electric transmission constants given. A mode of construction is proposed in which several coaxial conductor pairs are placed together in general heat insulation. Although it has not been tested, this type of construction should offer several advantages; ac losses and dielectric losses are discussed. The formulas developed are used to develop a model that corresponds to the Kingsnorth-London unit under construction at the present time. Considerable economic advantage is found for superconducting ac transmission for this system. The standard costs for this system would amount to DM 190 million, whereas the superconducting system proposed would cost DM 62 million. (BBB)

40932 A CONCEPT FOR A SYSTEMATIC TREATMENT OF PLANT DESIGN AND STRUCTURAL ENGINEERING FOR NUCLEAR INSTALLATIONS. Bender, M. (Oak Ridge National Lab., Tenn.); Jaeger, Thomas A. Nucl. Eng. Design, 9: 496-502(Apr. 1969).

An outline for a possible text on the plant design and structural engineering aspects of nuclear engineering practice is presented. Some of the topics discussed include: facing the problem of design for a new technology; hazard analysis and safety planning for nuclear installations; plant design principles for nuclear installations; balancing the aspects of function, safety, and economy; site selection with respect to safety; sources and interactions of nuclear radiation; radiation protection fundamentals; engineering considerations peculiar to nuclear installations; shield design analysis; mechanical devices for handling radioactive materials; ventilation and atmospheric control for nuclear installations; irradiation facilities (without contamination hazard); special engineering features of particle accelerators; radiation facilities with contamination hazard; structural and shielding aspects of nuclear reactor systems for power and research; reactor hazards, containment and siting; radioactive materials processing facilities; maintenance of contaminated equipment; transport of radioactive materials; and disposal of radioactive wastes. (J.C.W.)

40933 IRRADIATION APPARATUS WITH SPECIFIC MEANS TO LOAD AND UNLOAD A CHAIN CONVEYOR. Brunner, Alfred (to Sulzer Brothers Ltd.). U. S. Patent 3,452,195. Priority date Apr. 14, 1964, Switzerland.

The design of an irradiation apparatus in which a chain conveyer with closed loop paths is parallel to material transported to the area for irradiation is given. Roller conveyers are provided for bringing the loads of material to and withdrawing them from the chain conveyer. The roller conveyers are colinearly placed to each other and adjacent to the chain conveyer and perpendicular to the planes of the irradiation exposure path. The containers carrying the material to be irradiated are suspended on overhead rollers from rails located on the chain conveyer. A pusher bar serves at the loading station to push a container onto the chain conveyer into position to direct it to its first irradiation exposure, simultaneously pushing a second container into position to pass over the irradiation exposure area for a second irradiation, and also pushing a container off the conveyer which has already been over the second irradiation exposure path. (Offic. Gaz.) (TSS)

40934 CO-OPERATION: ESSENTIAL TO PROGRESS IN EUROPEAN PRODUCTION OF HEAVY EQUIPMENT FOR POWER STATIONS. OECD (Organ. Econ. Coop. Develop.) Observ., No. 39, 38-42(Apr. 1969).

The importance of technical cooperation in the design and construction of heavy equipment for large nuclear power installations among European nations is considered. Nuclear energy will account for 10% of the total capacity of the thermal power stations to be built in the European OECD countries between 1968 and 1971. By the end of 1971, 4% of the total generating capacity in these countries will be in the form of nuclear stations, which will cover 6% of the total load. In most cases, the nuclear units coming into service will have a generating capacity equal to that of the biggest conventional units built during the same period. (BBB) (TSS)

40935 CENTRIFUGAL MOLECULE SEPARATOR. Creutz, Edward C. (to Gulf General Atomic Inc.). U. S. Patent 3,460,318. Filed Dec. 14, 1966.

A method and apparatus for separating gases of different molecular masses include a helical or spiral capillary passageway, means for flowing a mixture of gases through the passageway, and means for removing gas fractions from the outer and/or inner surface of the passageway. The velocity of the gas mixture is sufficient to provide a centrifugal force field of at least about 10^5 g, but is less than the critical velocity above which flow within the passageway becomes substantially turbulent. (Offic. Gaz.)

40936 THERMOELECTRIC DEVICE COMPRISING AN OXIDE BASE THERMOELECTRIC ELEMENT. Precht, Walter (to Teledyne, Inc.). U. S. Patent 3,458,363. Filed Sept. 11, 1962.

A high-temperature thermoelectric power generating device is described that consists of an N-type thermoelectric element and a thermoelectric element of opposite conductivity type. The elements are electrically joined to form a thermoelectric couple. The N-type thermoelectric element has a room temperature resistivity no greater than 0.0225 ohm cm and is comprised of a semiconductor cermet material having the formula $ATiO_x + B$ where A represents one element selected from calcium, strontium, lead, and barium, and x is $< 3 > 0$, and B represents a pure metal particle additive phase selected from iron, nickel, molybdenum, chromium, cobalt and tungsten in the metallic state. (Offic. Gaz.)

40937 IMPROVEMENTS IN OR RELATING TO TUBULAR HEAT EXCHANGERS. **Hooper, Alan Thomas; May, William Charles; Sheeran, Lewis John (to United Kingdom Atomic Energy Authority). British Patent 1,159,034. July 23, 1969. Filed Aug. 4, 1965.**

A description is given of tubular heat exchangers for use where compactness is an important requirement, such as in marine reactors. In such applications it is difficult to arrange the heat exchangers so as to give a regular close-pitched tube matrix, due to limitations of minimum tube bent radii and header plate design. The system described comprises a heat exchanger arranged in a duct through which a first fluid makes successive passes along first and second paths separated by a baffle or baffles and having a number of tubes for conveying a second fluid for heat exchange with the first fluid. The tubes are connected in parallel between inlet and outlet headers, and each tube is formed into a number of runs to provide a number of successive second fluid passes in the first path, without reversal of the direction of bending, then crossing to the second path and acting in a similar way. At least some of the tube runs providing successive phases are planar. Several alternative arrangements are also described. (UK)

40938 NEW DEVELOPMENTS IN HOT-CELL EQUIPMENT. Grossstueck, W.; Weber, Klaus D. Kerntechnik, 11: 353-4 (June 1969). (In German).

A new method for constructing hot cells is described. An essential feature of the construction is a track or rail system in the cell which, when covered, forms a large working surface and which, when uncovered, serves as a transport, guidance, and positioning device for standard equipment used to machine materials in the hot cell. (L.C.L.)

40939 APPARATUS FOR X-RAY MEASUREMENTS ON REACTIVE MATERIALS AT 2500°C. **Harper, E. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., E (London), 2: 807-9(Sept. 1969).**

A high temperature attachment for a Philips x-ray diffractometer was built, enabling specimens to be examined in vacuum or inert atmosphere at temperatures up to 2500°C, while scanning angles from 0 to 140° 2θ. The apparatus was designed for use in a glove box with α-active and chemically reactive materials. It was used with uranium and plutonium compounds. (auth) (UK)

40940 AEROSOL MONITOR (May 16, 1969) (Engineering Materials). **(Sandia Labs., Albuquerque, N. Mex.). (CAPE-1899).**

19 drawings.

A real-time, high-volume monitor samples air and monitors aerosols in laminar flow clean rooms. A one milliwatt helium-neon laser is used as the light source producing a large light sensing zone. The 2 mm light beam is collimated to produce a 0.015 in. thick and 0.500 in. wide beam. The sensing system consists of the laser, laser beam collimator, sensing chamber and a photomultiplier tube. A commercial vacuum cleaner with variable control for volume of air moved is used to pull in the sample of air through the intake. The monitor makes it possible for industrial and medical users of laminar flow clean rooms to study particulate contamination on a real time basis. (For details see TID-4100 Suppl. 54.) (F.S.)

40941 APPARATUS FOR DETERMINING THERMOPHYSICAL PROPERTIES OF SOLIDS BY DIRECT ELECTRICAL PULSE HEATING. **Finch, R. A.; Taylor, R. E. (Atomics International, Canoga Park, Calif.). Rev. Sci. Instrum., 40: 1195-9(Sept. 1969).**

A pulse heating apparatus capable of initial heating rates of 7000 to 165,000°C/sec on 0.3175 cm dia samples of zirconium–uranium hydrides is described. Currents from 1000 to 5000 A are used. Potential drops, current, electrical resistivity, power input, sample temperature, and rate of hydrogen evolution as a function of time are recorded simultaneously during millisecond pulses. In addition, elongation, uniformity of heating, and sample temperature are recorded using high speed photography. The behavior of reactor fuels during large power transients has been observed using this apparatus. Properties which have been measured include specific heat, coefficient of expansion, electrical resistivity, phase transformations, heats of decomposition, and rates of hydrogen diffusion. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 40616, 40913, 40920, 40937, 41529, 41760, 42024, and 43141.

40942 (CEA-R-3600) HEAT TRANSFER IN SMOOTH TUBES, BETWEEN PARALLEL PLATES, ALONG A SEMI-INFINITE PLATE, IN ANNULAR SPACES AND ALONG TUBE BUNDLES FOR EXPONENTIAL DISTRIBUTION OF THE HEAT FLUX IN FORCED LAMINAR OR TURBULENT FLOW. **Graeber, Hans (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 280p. (In French). (EUR-3880). Dep.**

Thesis. Submitted to Univ. of Paris, France.

By introducing an additional parameter F_0, the processes for calculating heat transfer are extended to the heat flux distributions following an exponential law $q_w = \exp(mx)$ which give a heat transfer coefficient independent of position for laminar and turbulent flow with a linear pressure drop. For laminar flow along a semi-infinite plate, the heat flux distribution in accordance with the law $q_w = x^m$ leads to the Nusselt number, regardless of the position. Nu is then determined by the thickness of the thermal boundary layer. For the annular space, the equations for explicit calculation of the temperature field will be given, as well as the Nusselt number in laminar flow and constant heat flux. In turbulent flow, the laws of distribution of eddy diffusivity for momentum in a tube, adapted for the annular space and the tube bundle, gave the velocity field and the coefficient of friction and thus permit solution of the heat transfer equations. The results of the numerical calculation are tabulated for an extended range of the various parameters and compared with the experimental results. A simple process to determine the lower limit of the thermal entry length is also described. (auth)

40943 (GEAP-10009) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. **Thirteenth Quarterly Progress Report, October 1–December 31, 1968. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1969. Contract AT(03-4)-189. 21p. Dep. CFSTI.**

The nine-rod test section which was built specially for subchannel and flow structure measurements is described. Results of measurements of the velocity profile at inlet to test length are given. On the basis of these measurements, the honeycomb flow straighteners initially installed ahead of the channel inlet were removed. (auth)

40944 (RISO-M-894) VOID FRACTION MEASUREMENTS IN AN OUT-PILE HIGH-PRESSURE RIG MK II A BY THE IMPEDANCE BRIDGE METHOD. **Nielsen, Dan S. (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1969. 18p. Dep.**

The measurement of the void distribution along the electrically heated rod in an out-pile pressure rig by means of an impedance void detector connected to a simple impedance bridge is described. It is shown that by use of the impedance bridge in connection with a suitable operating procedure the drift problems connected with temperature changes during the measurements can be reduced considerably. (auth)

40945 (SCL-RR-69-83) AN EVALUATION OF THE USE OF THE FINITE ELEMENT METHOD IN THE COMPUTATION OF TEMPERATURE. **Emery, A. F.; Carson, W. W. (Sandia Labs., Livermore, Calif.). Aug. 1969. Contract AT(29-1)-789. 32p. Dep. CFSTI.**

A study is made of the accuracy and efficiency of the finite element method in comparison to the standard finite difference algorithms used for the computation of temperature. Numerical tests of linear, quadratic, and two cubic finite element models indicate that the quadratic model is the most accurate and desirable of these finite element models. It is demonstrated that for steady temperature distributions, with or without sources, the finite element models are superior to the finite difference method, but it also is shown that the finite element formulation may be used in forming a finite difference method which gives equal accuracy. However, the tests indicate that the normal finite difference method for transient problems which uses the Crank-Nicholson formulation is an order of magnitude faster in execution and requires an order of magnitude or more less machine core storage than the finite element method. It is generally concluded that if a well-documented and understood finite difference "thermal analyzer" is available, it is advisable to use it in its present form or at most to modify the conductances through the application of the quadratic finite element formulation. (auth)

Isotope Technology

Refer also to abstracts 40914, 41134, 41166, 41725, 42791, and 43170.

40946 (ORNL-4405) ELECTROMAGNETIC SEPARATION AND CHEMICAL REFINEMENT OF TUNGSTEN ISOTOPES. Love, L. O.; Spainhour, K. A.; Bell, W. A.; Davis, W. C.; Johnson, R. L.; Tracy, J. G.; Sheridan, C. W.; Snyder, A. H.; O'Donnell, F. R.; Underwood, J. N. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

More than 5 lb (2345 g) of ^{184}W with a purity of greater than 94% was separated and recovered from a series of runs made to enrich this isotope. Other tungsten isotopes collected concurrently were ^{180}W, 37 g; ^{182}W, 1957 g; ^{183}W (collected as ^{183}W^{16}O$^+$ sideband), 23.7 g; and ^{186}W, 1866 g. For this separation the calutrons were equipped with boundary plates for stabilizing the beam and with an all-graphite, two-arc, single-oven ion source, which increased the average output of W$^+$. The increased input of feed (WO_3) and chlorinating agent (CCl_4) required in this two-arc system severely loaded the two 20-in. calutron diffusion pumps. Therefore supplementary pumping with vaporized calcium was employed. As a result, the operating pressures were lowered which improved the beam transmission, and the material collected had the highest purity (97.6%) achieved in the series. (auth)

40947 (SC-DR-69-362) APOLLO LUNAR RADIOISOTOPE HEATER SAFETY EVALUATION. Baker, F. L.; Dalby, W. J.; Elkins, G. H.; Keller, L. L. (Sandia Labs., Albuquerque, N. Mex.). July 1969. 111p. Dep. CFSTI.

Safety evaluation tests and analyses of the Apollo Lunar Radioisotope Heater (ALRH) were performed to demonstrate the integrity of the capsule during postreentry impacts and in a Saturn V launch abort environment. A description of each test series and analysis is presented for air drop tests, shock tube tests, impact tests, pressure buildup analysis, and earth burial analysis. The tests conducted are considered extreme overtests, and severe conditions were assumed in the analyses. The evaluation indicates that the fuel container will survive these extreme conditions intact. (auth)

40948 (SC-PR-69-434) AEROSPACE NUCLEAR SAFETY PROGRAM QUARTERLY REPORT, APRIL 1-JUNE 30, 1969. Illing, R. G. (comp.) (Sandia Labs., Albuquerque, N. Mex.). July 1969. 30p. Dep. CFSTI.

Safety design specifications were prepared for the Transit heat source. Terminal velocities were calculated for an unablated hexagonal fuel block proposed for the Transit mission; terminal velocities and trajectories were calculated for four drop test configurations fuel blocks and fuel capsules. Droptests of four Pioneer heat source shapes were performed; the data are being reduced. One temperature response of the Apollo Lunar Radioisotopic Heater (ALRH) after earth burial was determined. A trajectory was computed for the GLFC multiple-orbit problem; the TTA computer program indicated that the GLFC would reenter on the 22nd revolution. (auth)

40949 (SC-RR-69-103) HECON COMPUTATIONS FOR THE DIFFUSION OF HELIUM IN ALPHA-EMITTING ISOTOPES. Northrup, C. J. M. Jr.; Amos, D. E. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 42p. Dep. CFSTI.

Alpha-emitting isotopic compounds are being used as heat sources for electrical generators. Because these compounds continuously produce helium, the behavior of the gas in each of the compounds is of great interest to engineers that are designing such systems. It has been demonstrated experimentally that some of the isotopic fuels will retain helium at lower temperatures. These fuels may rapidly release the stored gas if they are taken to high temperatures. Thus, there is considerable interest in the safety aspects of thermally cycling alpha-emitting compounds, since high pressures may be created in minutes. Two programs were obtained for diffusion in alpha-emitting compounds. An analytic solution is programmed as HECON1, and the program for the numerical solution is called HECON2. In general, HECON1 is limited to ideal laboratory conditions, but HECON2 can follow transients and complicated histories, such as might be seen by actual fuels. A Fortran computer program for the CDC-3600/6600 computers is included for the HECON2 solution. (auth)

40950 (UUIP-637) TABLE OF CALCULATED GAMMA-DOSE-RATES FROM SOME COMMON ISOTOPES. Bergman, C.; Norrby, S. (Uppsala Univ. (Sweden). Inst. of Physics). Mar. 1969. 7p. Dep.

The dose-rate from point sources was calculated for the most common isotopes which have a half-life of more than 1 hour and decay via emission of gamma quanta. (auth) (Sweden)

40951 ON THE DEVELOPMENT OF THERMOELECTRIC RADIONUCLIDE BATTERIES. Hesse, J. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main); Schmidt, E. F. Kerntechnik, 11: 258-65(May 1969). (In German and English).

Various designs of thermocouple generators are discussed, and the features of particular importance for use in space are summarized, together with results of experimental measurements. A 50 W generator with an electrically simulated radionuclide heat source, and an experimental battery with a small power output operated with the radionuclide curium-242 are described. (auth)

40952 METHODS OF MAKING SOURCES OF RADIOACTIVE ENERGY. Haskins, Arlie W. (to Susquehanna Corp.). U. S. Patent 3,457,181. Filed May 3, 1967.

In the manufacture of sources of radioactive energy, distribution of radioactive material within the source is controlled by introducing a solution of non-radioactive solute into the matrix, and/or coating lateral exterior surfaces of the matrix with non-radioactive material. The distribution of radioactive material is also controlled by contacting less than the entire matrix external surface with a solution containing a quantity of radioactive material, substantially all of which is capable of being introduced into the matrix prior to sealing the pores of the matrix by the application of heat. (Offic. Gaz.)

40953 URANIUM: GAS CENTRIFUGE PROJECTS. Mining J. (London), 272: 539-41(June 20, 1969).

The United Kingdom, Netherlands, and West Germany reached agreement on the development of the gas centrifuge technique for U enrichment. There would be, initially, 2 enrichment plants, each with an annual capacity of 50 tons. They would be built at Capenhurst, U.K. and at Almelo in the Netherlands, and they would go into production in 1972 or 1973. Later the capacity of each plant would be raised to 350 tons. First experimental success in Japan, in producing enriched U by centrifugal separation, was recently achieved by the Power Reactor and Nuclear Fuel Development Corporation with the cooperation of the Tokyo Institute of Technology. The centrifuge used has a revolving drum measuring 12 cm ID and was operated at 25,000 rpm. The drum at its external wall reached a rotating speed of 157 m/sec, almost half of the speed of sound. A separation factor of 1:1.015 was achieved. In a scheduled experiment, it is hoped to attain a separation factor of 1:1.069, using a larger centrifuge that is also twice as fast. (BBB)

40954 PROCESS FOR THE PRODUCTION OF RADIOISOTOPES. (to EURATOM). French Patent 1,407,583. Filed Sept. 14, 1964.

A process for the production of radioisotopes is described which comprises enclosing a substance to be activated in a member, e.g., a hollow control rod for a nuclear reactor, consisting of a material capable of absorbing thermal neutrons and of passing epithermal neutrons of a nuclear reactor, and then subjecting the member to neutron bombardment in a nuclear reactor. In a modification the substance to be activated is enclosed in the form of a layer between two layers capable of absorbing and passing neutrons as before. The two layers consist of materials having different neutron absorption coefficients. (NPO)

40955 USE OF THE ULTRACENTRIFUGE FOR THE ENRICHMENT OF URANIUM IN EUROPE. Bogaardt, M. Atoomenergie Haar Toepass., 11: 108-10(Apr. 1969). (In Dutch).

The ultracentrifuge process, based on a large number of drums, about two million by 1975 and five million by 1980, is discussed. It requires a relatively low investment and low power use, amounting to only about 10% of the gaseous diffusion process. Construction and operating experience in this field is expected to increase from an initial 20 to 100 × 10^3 kg/year to about 2.5 × 10^6 kg/year. Pooling of the German, Dutch, and British experience is expected to reduce the production costs to less than the projected $20/kg. (TTT)

40956 PROCESS FOR THE PRODUCTION OF RADIOACTIVE SUBSTANCES. (to Commissariat a l'Energie Atomique). French Patent 1,407,108. Filed June 5, 1964.

A process for neutron activation of a substance having a high neutron absorption cross-section is described. The process comprises mixing the substance with an additive having at least one chemical or physical property which is notably different from the corresponding property of the substance and having a much lower neutron absorption cross-section. The substance is in divided form and dispersed in the mixture. After the mixture is subjected to a neutron flux the substance is separated out by use of the differing property. For example, one of the substances and additives may be soluble and the other insoluble in a predetermined solvent, e.g., water, and the solvent is used for separating the substance and additive. Preferably the substance to be activated is reduced to a powder having a mean grain size smaller than the mean free path of neutrons in the substance. The mixture may be compacted into pellets having a cohesion sufficient to prevent settling of the substance during irradiation. (NPO)

40957 CONSTRUCTION AND CHARACTERISTICS OF MINIATURE SOURCES BY EVAPORATION. **Eschbach, H. L.; Grillot, A. (Bureau Central de Mesures Nucleaires, Geel, Belg.). Vide, No. 140, 97-104(Mar.-Apr. 1969). (In French).**

For the fabrication of thin layers of highly enriched isotopes by evaporation under vacuum, a series of different vapor sources has been constructed and tested. The evaporant is volatilized by resistance heating, electron bombardment, or rf induction. Reductions of oxides can be carried out directly in the miniature sources. This made special precautions necessary to avoid projections during the evaporation cycle. The construction and performance of these miniature sources are described and some typical results are discussed. (auth)

40958 DECONTAMINATION OF PAINTED SURFACES CONTAMINATED BY VARIOUS RADIOACTIVE ISOTOPES. **Miazek-Kula, Maria. Pr. Cent. Inst. Ochrony Pracy, 19: 89-96(1969). (In Polish).**

Tests involving decontamination of surfaces covered with oil, nitrocellulose, polychlorovinyl, and melamine paints, contaminated by radioactive isotopes ^{14}C, ^{32}P, ^{35}S, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{106}Ru, ^{125}Sb, ^{131}I, ^{137}Cs, ^{144}Ce, and ^{204}Tl are discussed. The effects upon the degree of decontamination by the kind of decontaminating agent, the time of decontamination, the number of contamination-decontamination cycles applied, and the time contamination had lasted were examined. The results of these tests revealed that decontamination is accomplished satisfactorily with the aid of a 1% solution of IXI detergent and, in some cases by a 5% Na_2CO_3 solution or a 2% elanol (or some other detergent) solution in 0.2 $\underline{N}$ H_2SO_4. (auth)

Materials Testing

Refer also to abstracts 40912, 40916, 41090, 41614, 41644, and 41714.

40959 (GAMD-9379) SMALL-SCALE TENDON FRICTION TESTS. **Chow, G. S.; Hildebrand, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). June 5, 1969. Contract AT(04-3)-633. 24p. Dep. CFSTI.**

Small-scale tendon friction tests for a prestressed concrete reactor vessel (PCRV) are described. The tests were conducted to evaluate the relative lubricity of the proposed lubricants by stressing a seven-wire ($^1/_4$-in.-diameter) tendon through a $1\,^5/_{16}$-in.-diameter tube. The results of this series of tests in conjunction with the results of radiolysis tests on the same lubricants will be used in selecting the most suitable coating material for the R & D Friction Test Program using full-size (168-wire) tendons and simulating the Prestressing System for the PCRV of the Fort St. Vrain Power Reactor. A summary of the friction test results is tabulated and evaluation of the test results is discussed. (auth)

40960 (ORNL-TM-2501) COMPUTER PROGRAMS FOR SOME EDDY CURRENT PROBLEMS. **Luquire, J. W.; Deeds, W. E.; Dodd, C. V.; Spoeri, W. G. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 191p. Dep. CFSTI.**

Computer programs for solving some eddy-current problems frequently encountered in nondestructive testing are described. Operating instructions and examples are given for each program. These programs are written in BASIC language and may be used on a time-sharing computer. Various eddy-current tests can be quickly and accurately designed by utilizing these programs. (auth)

40961 EXPERIMENTAL STUDIES ON THE EMBRITTLEMENT BY HEATING PROCESS IN THE PRODUCTION AND THE RADIOGRAPHICAL INSPECTION OF THE PART WITH FIXED NOZZLE FOR THE REACTOR PRESSURE VESSEL. **Yosetsu Gijutsu, 17: No. 3, 73-86(Mar. 1969). (In Japanese).**

In the experiments, ^{60}Co and ^{137}Cs γ-ray and 400 kVA and 260 kVA x-ray machines were employed. The relations between exposure and shade, and between shade and discernibility by the penetration meter, were determined, and the allowable difference and the applicable range of steel plate thickness by which good discernment can be expected in the shade range of $1.5 \sim 3.5$ were shown, for each photosensitive film and lead foil sensitizer. The artificial weld defects in the pipe root and the part with inserted nozzle were discerned using 15 MeV betatron and ^{60}Co; the discernibility of defects in accordance with the photographing conditions was elucidated. For measurement of defect locations, there are two methods of three dimensional and division-in-stratiform photography. A measuring method which can be carried out simply in a field with less errors was investigated. The defect locations in the specimens from the fixed nozzle were determined, and the accuracy of their measurement is reported. (NSA of Japan)

40962 NONDESTRUCTIVE TESTING OF JET-ENGINES BY USING ^{192}Ir. **Kobayashi, Masatoshi; Enomoto, Shigemasa; Maeda, Sho; Matsuo, Yoshiro. Nippon Genshiryoku Gakkaishi, 11: 419-24(1969). (In Japanese).**

A series of nondestructive tests on jet engines using 10 Ci of ^{192}Ir were undertaken. To examine the possibility of applying this method in actual practice, detailed test programs were prepared in advance for trials on two types of engines for jet planes—Boeing 727 (JT-3D engine) and Douglas DC-8 (JT-8D engine). With the engine cover removed, a steel guide tube was inserted into the hollow turbine shaft, and the radioactive source was positioned in the predetermined point along the guide tube. An x-ray film of fine grain and high sensitivity was placed in a flexible holder with a lead screen, and set over the surface of the jet engine. After each exposure, the radiographic image was examined for detection sensitivity. The trials were successful, and effective detection was promised of anomalies in such components as compressor blades and guide vanes, and combustion chamber lining, as well as turbine blades and vanes. The airline company adopted the method for their routine operations. (auth)

40963 DEVICE FOR INSPECTING A SOLID LIMITED BY TWO SUBSTANTIALLY CONCENTRIC SPHERICAL SEGMENTS. **Bonduel, Louis Fernand; de Cuissart, Jean Marc Digard (to Commissariat a l'Energie Atomique). British Patent 1,161,380. Aug. 13, 1969. Priority date Apr. 11, 1967, France.**

A device is described for use in inspection of solids which are limited by two substantially spherical and concentric segments and by a flat surface. The device is primarily applicable to solids in which the two segments are limited by an equatorial plane of the spheres. (J.R.D.)

40964 NONDESTRUCTIVE TESTING. **Egerton, H. B., (ed.). Harwell Post-graduate series. Oxford, University Press, 1969. 240p. 50s.**

A review is presented under the following main headings: Processing of NDT data; electronic approach to NDT; implications for the designer of advanced NDT techniques; estimation of grain size in metals; recording ultrasonic micrometers; automatic profile recording; acoustic emission from materials; practical neutron radiography; television radioscopy as an inspection tool; capacitance gauge for measurement of tube bore; holography; radioisotope techniques in process control and analysis; radioisotope techniques for coating thickness measurement and analysis; leak detection techniques; inspection techniques for pressure containment materials and components; ultrasonic probe technology within the UKAEA; manufacture of probes; and non-destructive testing information (selected references to work by UKAEA authors). (UK)

Radioactive Material Handling

Refer also to abstracts 40925 and 41564.

40965 (ARH-1206) PHOTOGRAPHY IN UNDERGROUND RADIOACTIVE WASTE STORAGE TANKS. **Godfrey, W. L.; Meyers, C. D. (Atlantic Richfield Hanford Co., Richland, Wash.); Hascall, J. L.; Everett, J. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-2130. 49p. Dep. CFSTI.**

The high level radioactive waste solutions generated at Hanford during the processing of spent reactor fuels are stored in underground tanks ranging in size from 500,000 to 1,000,000 gallons and in some cases the radioactive decay heat present is sufficient to cause the solutions to boil. Techniques were successfully developed to overcome problems of temperature, humidity, and personnel and equipment irradiation and contamination while photographing the inside of these tanks. The number of tanks involved put a premium on portability, while twelve-inch acess pipes limited the equipment size. Remote aiming mechanisms were developed, as was a portable exhauster which removes fog and at the same time controls airborne contamination. A balance was reached between the faster films, which are more susceptible to radiation damage, and light sources which would fit through the available access ports. A lens purge was developed to prevent condensation on the camera and bagging techniques were developed to prevent equipment contamination. Excellent quality pictures have been obtained which have significantly reduced costs by allowing the rapid evaluation of operating performance, and have increased safety by providing a more rapid and sure evaluation of operating problems. (auth)

40966 (BNWL-tr-38) TREATMENT AND CONDITIONING OF SOLID RADIOACTIVE WASTES. Cerre, P.; Mestre, E. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report CEA-2147. 17p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 16: 25034.

40967 (CEA-R-3751) STUDY OF THE DIFFUSION OF THE RADIOACTIVITY OF GLASSES AND BITUMEN-COATED MATERIALS. Rodier, Jean; Marichal, Maurice; Benoit, Roland (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule); Niezborala, Fernand; le Bouhellec, Joel (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1969. 30p. (In French). Dep.

Glass pellets obtained from concentrated fission product solutions were subjected to the action of water, under conditions similar to those of still water, renewed water, and running water. The retention by a given type of soil of the contamination in waters used for lixiviation was also studied. A comparison was made between various coating processes (bitumen or cement) and vitrification from the point of view of the behavior in the soil of residues thus treated. The overall results made it possible to choose between the different modes of storage as a function of the activity of the residues to be processed. (auth)

40968 (DP-1189) USE OF SAND AS A PREFILTER FOR ION EXCHANGE COLUMNS. Hawkins, Richard H.; Horton, J. Henry (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1969. Contract AT(07-2)-1. 11p. Dep. CFSTI.

In laboratory tests, a sand prefilter minimized pluggage in an ion exchange resin column when used to purify water from a Savannah River Plant storage basin for fuel elements. (auth)

40969 (JPRS-48229) HANDLING OF RADIOACTIVE WASTES AT SOVIET ATOMIC POWER STATIONS. Kolychev, B. S.; Matveev, A. N.; Khomikevich, A. A. Translated from At. Energ. (USSR), 26: 411-19(May 1969). 15p. CFSTI.

Radiation monitoring in the environment near NVAES and BAES atomic electric plants in the Soviet Union is described. Previous data obtained indicate that the natural background radiation levels are caused by global fallout alone. Contamination in the soil, vegetation, and bottom deposits of the Don River is also at the radiation background level. Processing, decontaminating, and storage of radioactive wastes are operating reliably. Equipment for handling the radioactive wastes is discussed. (J.C.W.)

40970 (JPRS-48244) RADIOACTIVE WASTE DISPOSAL NO LONGER HAZARDOUS. Barykin, K.; Bal'termants, D. Translated from Ogonek, No. 13, 16-17(Mar. 25, 1969). 11p. CFSTI.

The underground storage of radioactive wastes in Russia is discussed. Safety aspects of the storage procedures are described. (L.C.L.)

40971 (KFK-903) METHODS FOR INDEPENDENT DETERMINATION OF PROCESS INVENTORY IN NUCLEAR FACILITIES: FABRICATION PLANT. Larisse, J.; Winter, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Dec. 1968. 77p. Dep.

Basic assumptions needed for description of fissile material flow through a fabrication plant are defined. Aspects of a mathematical model of the plant are examined. Possibilities of process inventory methods are explored and these concepts are applied to an existing fabrication plant for plutonium-bearing fuel elements. (J.R.D.)

40972 NUCLEAR POWER GROWTH SPURS INTEREST IN FUEL PLANT WASTES. Slansky, Cyril M.; Peterson, Henry K.; Johnson, Vernon G. (Idaho Nuclear Corp., Idaho Falls). Environ. Sci. Technol., 3: 446-51(May 1969).

The steady and continuous release of ^{85}Kr from nuclear reprocessing plants is discussed. Variables to be considered in studying the nuclear waste management are rate of waste generation, stack height, local meteorology, nature of the terrain, time interval on which the dose is calculated, and downwind distance for which a certain populace is concerned. Location of plants, dose criteria, and economics of management methods of gas release are discussed. Processes being investigated for ^{85}Kr off-gas treatment include room temperature adsorption on charcoal beds or molecular sieves, low temperature adsorption on charcoal beds or silica gel, cryogenic distillation, liquid extraction, clathrate precipitation, permselective membranes, and thermal diffusion. Costs and comparisons of the methods are evaluated. (J.C.W.)

40973 HOT CELLS FOR POST-IRRADIATION EXAMINATION OF FUEL ELEMENTS. Podest, Milan; Pour, Frantisek (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ., 15: 192-6(June 1969).

The preparation of a hot work area was directed towards equipping the hot cells with apparatuses and devices that would allow fundamental operations of the post-irradiation investigation of ceramic fuel materials following irradiation in a reactor. Initially the workplace was equipped with the apparatuses and devices used to investigate visible changes on the surface of fuel cans and irradiation capsules, and to control the burnup by nondestructive methods. This was supplemented by equipment for sectioning the irradiated specimens and their preparation for detailed metallography. Equipping the cells with devices of this kind is very difficult because all devices are unique and they need to be designed and manufactured individually; and they cannot be used in active operation immediately after manufacturing. In most cases, a relatively long testing operation is required during which additional adaptation must be made. (J.R.D.)

40974 PROTECTIVE CELL "PETRUS" FOR THE PRODUCTION OF ^{252}Cf. Sontag, Rene; Berger, Rene (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Energ. Nucl. (Paris), 11: 154-60(May 1969). (In French).

The alpha, beta, gamma, neutron cell Petrus is devoted to the transplutonium element production and study. It is located at the CEN in Fontenay-aux-Roses (France). The 4 feet ordinary concrete shielding made of stacked blocs allows the manipulation of radioactive sources as high as 1000 curies of 1 MeV gamma rays and with a fast neutrons flux of 10^9 n.cm^{-2}.s^{-1}. The general equipment and the main setting up are described. (auth)

40975 TECHNICAL ASPECTS AND ECONOMIC INCIDENCES OF TRANSPORT IN THE FUEL CYCLE. Sousselier, Y.; Labrousse, M. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris), 11: 96-103(Mar.-Apr. 1969). (In French).

The fuel cycle calls for transports at many stages including transport of ores from the mines to the concentration plants; transport of concentrates of the refining plants; transport between the refining, enrichment, and fuel element production plants; transport of unirradiated fuel to the reactors; transport from the reactors to the reprocessing plants; and transport of waste to the storage areas. Their number and variety as well as the requirements of the regulations with which they have to comply have a noticeable incidence on the total cost of the fuel cycle. However, the C.E.A.'s experience in packaging, design, and transport operation at every stage has shown that it was possible to reduce these costs to a great extent by examining carefully the various technical solutions and the other various components of the transport costs. The costs of the various transports intervening in the fuel cycle of different types of reactors are indicated, as well as the total costs that can be expected in a complex including graphite gas reactors of a 3,800 MWe total power feeding a 1,000 MW(e) breeder. A survey of the probable developments of these costs in the future is included. (auth)

40976 SPENT-FUEL TRANSPORT CONTAINER. Nakai, Yasushi (to Mitsubishi Atomic Power Industries, Inc.). Japanese Patent 1969-10358. May 14, 1969. Filed Sept. 12, 1966.

The spent fuel transport container proposed uses a low-melting-point metal as the coolant for contained spent fuel instead of the ordinary coolant water. The coolant metal has a high radiation shielding power compared with water, and therefore, the weight of a transport container can be small relative to the case using coolant water. The transport container consists of the following: the container body of a radiation shielding material; the cover of a radiation shielding material; the support for spent fuel rods within the container; a low-melting-point metal immersing the fuel rods in the container, which melts at a temperature lower than that of the fuel rods; a pump for circulating the molten metal throughout the interior of the container; a means to drive the pump; and a torque detector for observing the solidification of molten metal so as not to overload the operating pump. Wood's metal can be used as a coolant. Cadmium is present in the metal to prevent criticality. (NSA of Japan)

40977 CONTAINER FOR TRANSPORTING RADIOACTIVE MATERIALS. Motomiya, Kimio (to Hitachi Ltd.). Japanese Patent 1969-9960. May 9, 1969. Filed May 2, 1966.

The proposed container is for transporting radioactive materials such as in-pile irradiated materials or spent nuclear fuels. It is made of lead to give the shape of a container; both the outside and the inside surfaces are surrounded tightly with steel plates to keep the integrity of the container. When the lead is heated, for example, due to a fire, and subsequently expanded, this expansion can be adequately absorbed, preventing the rupture of the steel plates and hence the container itself. The container body is a solid lead block, with a central hollow to contain radioactive materials; the lid is also a similar lead block. The outside and inside surfaces of both the container body and the lid are tightly covered with steel plates, to strengthen the structure. Along the circumference of the central hollow, the steel plate is corrugated. When the lead is heated and then expanded, this expansion is absorbed by the corrugated part of the lining steel plate; no molten lead then flows out of the steel lining, keeping the integrity of the container. (NSA of Japan)

40978 PROTECTIVE DEVICE WITH FORCED COOLING FOR A RADIATION SOURCE. **Imai, Takeshi** (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-12787. May 27, 1969. Filed June 25, 1965.

In a certain type of radiation source, the source rods are arranged in the form of a cage, and samples for irradiation are placed either within or outside the cage of source rods. The radiation-source rods radiate heat, and this heat adversely affects the samples for irradiation, and also the cage of source rods is subjected to undesirable environments. A method is proposed in which the removal of heat and protection are achieved effectively and simply. The cage of source rods is made in the form of a cylinder with the rods along the circumference; the cage itself is set on the table. A casing is placed over the cage, just surrounding the cylindrical shape, to enclose the whole cage of source rods. Openings are provided in the side wall near the bottom, and also on the top circular end of this cylindrical casing. Cooling air is passed through the casing, entering at the bottom openings and leaving from the top. (NSA of Japan)

40979 STATUS OF RADIOACTIVE WASTE DISPOSAL IN U.S.A. **Parker, Frank L.** (Vanderbilt Univ., Nashville). J. Sanit. Eng. Div., Amer. Soc. Civil Eng., 95: 439-64(June 1969).

The main emphasis in research studies of liquid radioactive management has been: demonstration of the effectiveness and economic feasibility of conversion to solids of the higher level liquid wastes; conversion to solids in place and in the ground for low and intermediate level waste; and determination of the fate and hazard of the minor quantities of liquid waste discharged to the environment. For gaseous wastes, the emphasis has been on the removal of the various forms of iodine in the off-gas systems and the development of new methods for noble gas removal. For solid waste disposal, better containment has been sought, and private burial operations have been transferred to commercial burial grounds. The management of radioactive wastes has not proven to be a deterent to a nuclear power economy. The major problems remaining are methods for the removal of noble gases and tritium, development of fuel reprocessing methods, and understanding of the movements of radionuclides in the environment. The effects of releases of radioactive materials upon man, and a comparison of these effects with similar effects produced by natural causes, are also considered. The estimated average radiation exposures to the gonads in the United States in 1963 was 193.2 mrem, and ~1% of this dose was due to the nuclear industry. Radioactive wastes are not at present, and do not appear to be in the future, a deterent to a nuclear-power economy, and cancers and genetic deaths due to a nuclear-power economy are small in comparison to cancers and genetic deaths due to natural causes. (BBB)

Vacuum Engineering

Refer to abstracts 41179, 42801, and 42817.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 40610, 40797, 41130, 41144, 41993, 42815, and 43213.

40980 (AECL–3368) RESPONSE OF COBALT NEUTRON FLUX DETECTORS. Sovka, J. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 31p. Dep. CFSTI (U. S. Sale Only). CAN $1.00.

Self-powered neutron detectors are being used to measure and control the flux in research and power reactors. For monitoring, the detector current due to β-decay of short-lived radioisotopes, e.g., ^{104}Rh (42 s) and ^{52}V (3.76 m), provides adequate response time. For controlling rapid flux transients faster detector response is required for which the "prompt-response" cobalt detectors were developed. However, the neutron activation products ^{60}Co (5.27 y) and ^{61}Co (99 m) contribute a background signal that increases with detector irradiation. The resulting reduction of the prompt signal-to-background ratio limits the useful life of cobalt detectors. The results of a theoretical investigation of their response through a study of the prompt and background signals as a function of irradiation time at different fluxes are described. (auth)

40981 (BMwF-FBK–69–8) CONTRIBUTION TO THE IDENTIFICATION AND SPECTROSCOPY OF CHARGED PARTICLES PRODUCED BY NEUTRON AND PROTON INDUCED REACTIONS. Philipp, G. (Erlangen Univ. (West Germany). Physikalisches Institut). Mar. 1969. 17p. (In German). Dep.

A counter telescope for the identification and spectroscopy of charged particles produced in fast neutron-induced reactions is described. Background reduction is obtained by the use of coincidence-anticoincidence electronics. The different types of particles are distinguished by analog pulse multiplication. The possibility is discussed whether the conclusion that there is cluster formation on the surface of medium and heavy nuclei can be drawn from the separated energy spectra of protons, deuterons, tritons, ^{3}He and ^{4}He particles. The measurements with 14 MeV neutrons are elaborated by experiments with charged particles performed at the tandem accelerator in Erlangen. In many of these experiments the discrimination of particles can be achieved by varying the depletion depth of surface barrier detectors alone. (auth)

40982 (BNWL–1154) WHOLE-BODY COUNTER LABORATORY, MOBILE UNIT B, DESCRIPTION AND OPERATION. Eichner, F. N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 41p. Dep. CFSTI.

The Whole-Body Counter Laboratory contains a number of highly specialized mechanical and electronic instruments designed to measure and record the radionuclide body burden of humans. The system is composed of a five-ton lead shadow-shield counting chamber with pallet and pallet-drive assembly and a 11$^1/_2$ inch diameter by 6 inch thick, sodium iodide crystal, equipped with seven photomultiplier tubes. It also includes a pulse height multichannel analyzer and data readout system; a paper tape punch unit; a paper tape reader; a high speed printer; a high voltage power supply; and a line voltage conditioner to regulate electrical power to the electronic equipment. The laboratory is built into an 8 by 18 foot, fiberglass insulated, van which is temperature controlled by a heat pump. The van is mounted onto a truck rated at 12-ton gross weight. Power requirements for the laboratory are 20 A at 208/240 V ac. Detailed procedures for operation and routine maintenance are presented. (W.H.K.)

40983 (CEA-R–3829) PREPARATION AND STUDY OF THE PROPERTIES OF LEAD TELLURIDE AND CADMIUM TELLURIDE DIODES FOR USE IN NUCLEAR SPECTROMETRY. Lancon, Rene (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1969. 106p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

The possibility of using high atomic number compound semiconductors (lead telluride and cadmium telluride) to realize nuclear radiation detectors, especially for gamma ray spectrometry because of their high absorption coefficient, is discussed. The problems related to the preparation of binary compounds are exposed. Experiments on PbTe show the influence of the conditions of preparation on the electrical properties of the semiconductor which are greatly dependent on the stoichiometry of the compound. PbTe surface-barrier diodes were realized and have been used to study the surface properties of this semiconductor. These diodes cannot detect nuclear radiations because of the weak resistivity of the material used. Different types of devices made of CdTe have been studied. One of these diodes has been used as an alpha particle detector. The relatively poor performances of this detector is explained by the presence of lattice defects in CdTe where charge carriers may recombine themselves. By analyzing the properties of gold diffused CdTe diodes this defect, the cadmium vacancy, which is due to the deviation from stoichiometry during the preparation of the material, was identified. (auth)

40984 (CLOR–73/D) MEASUREMENTS OF IONIZING RADIATION DOSES IN DWELLINGS IN POLAND. Pensko, J.; Mamont, K.; Wardaszko, T. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1969. 16p. (In Polish). Dep.

A portable background gamma-radiation dosemeter with a high-pressure ionization chamber was designed. The measurements of the gamma background radiation dose rate and radon concentration in air of the 97 new flats were performed. The flats were chosen from among the houses in Experimental Settlement in Sluzewiec (quarter of Warsaw), in three settlements of Lódź and in five settlements of the Higher Silesia Industrial Area. For the construction of these settlements the building materials were used which are by-products of the iron and steel industry or contain the fly ash removed from the coal power station. These materials are typical for the new building industry in Poland. The estimated dose rates are similar in the houses to those out-of-door but radon concentration inside buildings are several times higher than outside. (auth)

40985 (EUR–4289, pp 85–91) DESIGN OF A WIDEBAND PULSE AMPLIFIER WITH LINEAR INTEGRATED CIRCUIT μA 702A USING FREQUENCY COMPENSATION TECHNIQUE. Lero, N. P.; Frantlovic, P. B. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)).

The possibility has been considered to use a commercial linear integrated device for amplification of proportional radiation detector pulses in pulse counting assemblies. Principal requirements with respect to the amplifier gain and bandwidth have been specified, and choice has been made of the most suitable linear integrated device. Stability analysis of the chosen device has been carried out, and appropriate frequency compensation made it possible to satisfy the imposed requirements. Experimental results are in good conformity with analytical conclusions. (auth)

40986 (EUR–4289, pp 93–4) SHAPING AND TIMING CIRCUITS WITH ALTERNATIVE SYMMETRIC AND ASYMMETRIC INPUT AND OUTPUT CONFIGURATIONS. Horvath, Pavel; Ondris, Lubomir (Joint Inst. for Nuclear Research, Dubna (USSR)).

Shaping and timing circuits with both symmetric input and asymmetric output and the inverse configuration are described. Good rejection of undesired signal components, which appear at the output as a result of coupling effects and of non-ideal circuit element properties, is achieved. (auth)

40987 (EUR–4289, pp 95–100) INFLUENCE OF THE COMPENSATED THICKNESS OF COAXIAL Ge(Li) DETECTORS AND OF NOISE SOURCES ON TIMING PROPERTIES. Miehe, J. A.; Siffert, P.; Stuck, R.; Coche, A. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires).

Starting with equal diameter germanium crystals, double open ended Ge(Li) coaxial diodes were fabricated in which the compensated region is varied by 2 mm steps. The spread of the charge collection times and the time resolution are studied simultaneously. The influence of other parameters, such as the triggering level of the fast discriminator are analyzed. The results are compared to those of a planar counter having the same sensitive thickness. The influence of parallel and series noise sources are studied. (auth)

40988 (EUR–4289, pp 101–6) PLASMA EFFECTS FOR α PARTICLES AND ^{16}O IONS IN SILICON DETECTORS. Tove, P. A.; Seibt, W.; Sundstroem, K. E. (Uppsala Univ. (Sweden). Inst. of Physics).

Injection of strongly ionizing particles such as α-particles and oxygen ions into semi-conductor detectors give rise to plasma effects which change the simple picture of charge collection valid for lightly ionizing particles, e.g., protons. The observable current pulse in the detector therefore becomes different in the mentioned three cases. Measurements results are compared with a previously designed theoretical model which assumes that erosion of the created plasma is caused by transient space charge limited currents from the plasma edge. (auth)

40989 (EUR-4289, pp 137-9) FAST TIME MARKING DISCRIMINATOR CIRCUIT. Fiebiger, N.; Elzer, P.; Emmerich, W. D.; Hofmann, A. (Erlangen-Nuernberg Univ. (West Germany). Physikalisches Institut); Klein, J. W. (Frieseke und Hoepfner G.m.b.H., Erlangen-Bruck (West Germany)).

A leading edge threshold discriminator with 60 dB threshold range, a time walk of less than 0.1 ns/dB and 10^6 pps repetition rate making use of linear integrated circuits is described. It is designed for time measurement with coincidence stage or TPC with signals from solid state detectors via charge amplifiers or scintillation counters. (auth)

40990 (EUR-4289, pp 211-15) A NORMALIZING ADC FOR USE WITH POSITION SENSITIVE DETECTORS. Miller, G. L. (Bell Telephone Labs., Murray Hill, N. J.); Senator, A. (Rutgers-The State Univ., New Brunswick, N. J.).

Position-sensitive detectors based on the principle of resistive charge division require a normalizing operation in order to extract the position information. In the present case this operation is carried out within a special ADC, whose inputs are the detector output signals and whose output is the normalized digital position information. The conversion is carried out by using a ramp ADC in which the position signal defines the peak voltage on a stretcher capacitor, while the total charge signal defines the rundown current. The entire system, from the preamplifier inputs to the digital output, is servo-stabilized. This is achieved by periodically injecting reference pulses of fixed and known amplitude ratios into the preamplifier inputs. These reference signals correspond to two fixed positions on the detector, and the servo stabilizer demands that these positions correspond to two preassigned channel numbers. Electrical tests indicate a precision of ~0.1% for a 2 to 1 range of total signal charge, while tests with 12 MeV deuterons (using an 80 cm long proportional counter) give a fwhm position resolution of ~0.2%. (auth)

40991 (EUR-4289, pp 217-20) DIRECT DIGITALIZATION OF THE QUOTIENT OF TWO PULSE HEIGHTS. Carpay, W. M.; Klein, S. S. (Technische Hogeschool, Eindhoven (Netherlands)).

A fast quotient digitalization circuit (QDC) for use with position-sensitive detectors is described. The larger pulse is used as reference in a nonsynchronous successive approximation ADC. A speed of more than 5 bits/μs and 7-bit-accuracy over a range of 0.5–5 V for the larger pulse may be obtained. The use of stretched pulses is not necessary if the pulse shapes are similar. (auth)

40992 (EUR-4289, pp 237-42) DEADTIME CORRECTIONS IN A TWO-PARAMETER SYSTEM CONTAINING FOUR DETECTORS. Grosshoeg, Gudmar (Chalmers Tekniska Hogskola, Goteborg (Sweden)).

A study of the deadtime correction in a complicated counting system is performed. It is shown how the transfer of information can be divided into extrinsic and intrinsic transfer. The intrinsic transfer depends on the total information flow from all detectors and has been treated with an experimental method, which is compared to a numerical model. The extrinsic transfer depends on the information flow in each detector line. It is shown that this effect can be studied through pile-up. (auth)

40993 (EUR-4289, pp 247-50) WIRE PROPORTIONAL COUNTER ARRAYS WITH FAST DIGITAL ARITHMETIC FOR DECISION MAKING. Koester, L. J.; Brown, R. M.; Koetz, U.; Clark, T.; Segler, S.; Taylor, R. (Illinois Univ., Urbana. Dept. of Physics).

Multiwire gas proportional counters have been tested with a finely collimated beam of 1 GeV/c particles. In each case, the distance from wires to wall was $\frac{1}{4}$ inch, and 0.002 inch stainless steel wires were used. Wire spacings of $\frac{1}{8}$ inch and $\frac{1}{16}$ inch were compared. With a 90% argon, 10% methane filling at one atmosphere, the operating voltage was 3.0 kV for $\frac{1}{8}$ inch and 4.7 kV for $\frac{1}{16}$ inch spacing. Efficiencies greater than 99% were achieved, and little difference in timing was observed between the two geometries. A mixture of 90% Ne, 10% He bubbling through heptane at 0°C required 1.95 kV for 1.16 inch spacing but did not improve the time jitter. Running alternate wires at negative voltage also did not improve the jitter. These counters have been used to trigger spark chambers. A new scheme of fast arithmetic is in preparation for making decisions. (auth)

40994 (EUR-4289, pp 269-76) COMPUTERIZED DATA ACQUISITION SYSTEM FOR HIGH EVENT RATES FROM MANY SOURCES. Dimmler, D. G. (Brookhaven National Lab., Upton, N. Y.).

Semiconductor banks with many individual counters can impose very high data rates on a computerized data acquisition system even with modest individual detector rates. The purpose of this paper is to discuss some results of a design study made for a data acquisition and control system used in an x-ray diffractometer. The system collects, processes, and records up to 385,000 events per second, detected from several semiconductor banks with 128 counters each. An integrated diode matrix, a derandomizer and an external memory arrangement will be described. Also, some system software considerations will be mentioned. (auth)

40995 (EUR-4289, pp 333-8) METHODS OF REDUCING THE NUMBER OF BINARY DIGITS REQUIRED TO CONVEY RANDOM COUNTING-RATE INFORMATION. Cooke-Yarborough, E. H. (Atomic Energy Research Establishment, Harwell (England)).

The digits resulting from counting random events can be encoded in ways which reduce the communication bandwidth required to transmit them to a remote point. A number of ways of doing this have already been reviewed; two further methods are presented which appear to have significant advantages. (auth)

40996 (TID-25164) SPARK COUNTER NEUTRON DETECTOR FOR HIGH-TEMPERATURE APPLICATIONS. Final Report. Eichholz, Geoffrey G. (Georgia Inst. of Tech., Atlanta). June 1969. Contract AT(40-1)-3563. 51p. Dep. CFSTI.

Spark counters of the corrugated electrode type were designed and tested for use as neutron detectors in high neutron fluxes and at high temperatures. These detectors consist of a gas-filled coaxial assembly, in which circular ridges, acting as spark gap electrodes with the cylindrical outer container, are interleaved with boron-containing disks, which act as neutron converters by producing alpha particles by the ${}^{10}B(n,\alpha){}^{7}Li$ reaction. These alpha particles trigger a spark across the gap, producing a large current pulse that is readily detected and counted. With argon or helium gas fillings, such counters were operated at temperatures up to 1076°F at which point the leakage currents across the ceramic insulator seals became excessive. The counters were tested in a wide range of neutron fluxes, up to 6×10^{10} n/cm^2 sec, and gamma-ray fields, up to 2×10^5 R/hr. The counters were found to have a linear response in neutron fluxes up to 6×10^9 n/cm^2 sec in the presence of gamma-ray fields of the order of 10^4 R/hr. Above that level the response became increasingly nonlinear as gas ionization due to primary and secondary gamma-rays became significant and ultimately suppressed the spark mechanism at fluxes of the order of 3×10^{10} n/cm^2 sec. Attempts to extend the range of high flux response significantly by variations in gas pressure have not been successful. The detector sensitivity at low and medium fluxes is of the order of 10^{-8} counts/neutron and can be varied by increasing or decreasing the number of converter disks. (auth)

40997 (UCRL-50633) TELEMETRY SYSTEM FOR MONITORING GAMMA RADIATION IN PLOWSHARE EXPERIMENTS. Onaka, Wayne T. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 8, 1969. Contract W-7405-eng-48. 15p. Dep. CFSTI.

Ground gamma-radiation levels produced by debris from nuclear-excavation or cratering experiments are telemetered from monitoring stations to a base station up to 100 miles away. At the monitoring station an ion-chamber/electrometer provides a voltage that is logarithmically related to the ground gamma level. On command, the voltage is transmitted to the base station via a voltage-controlled oscillator and FM telemetry. Up to 13 other commands are available for operating auxiliary equipment that includes fallout trays and air samplers. (auth)

40998 (UCRL-71625) A HIGHLY SENSITIVE PHOTORESPONSE TECHNIQUE FOR DETERMINING IMPURITY AND DEFECT ENERGIES AND CONCENTRATIONS IN GERMANIUM. Armantrout, G. A. (California Univ., Livermore. Lawrence Radiation Lab.). July 17, 1969. 22p. (CONF-690808-3). Dep. CFSTI.

From 3rd International Conference on Photoconductivity, Stanford, Calif.

Ge(Li) detectors, which are very high resolution gamma-ray spectrometers, are very sensitive to the presence of carrier traps in the compensated region of the detector. It is very important to be able to study traps whose density ranges down to 10^{11}/cm^3, since this density can result in a significant degradation of detector performance. The most useful technique for these studies was the measurement of the monochromatic infrared response of the detectors. The infrared response characteristics of a diode structure are different from those of a photoconductor, since in the former the formation of a complete electron-hole pair is required before a significant output can be observed. This complete pair formation can be thermally assisted or can result from successive photoexcitation of the carriers through allowed energy levels for photon energies less than the bandgap energy. An analysis of the resulting spectrum provides information concerning the responsible trapping centers in a given Ge(Li) detector. The properties of traps caused by copper, nickel, iron, and lithium in the Ge(Li) detectors were studied using this technique. Both precipitated copper and precipitated lithium introduce a continuum of levels extending into the bandedge, while the deep level of substitutional copper is shifted as a result of lithium-ion pairing. Nickel and iron showed no evidence for level continuum formation, but introduced the commonly observed deep energy levels. A lithium-defect interaction, distinct from the precipitated lithium phase, was observed which introduced a deep donor level at $E_c-E_t = 0.22$ eV, with excited states extending to $E_c-E_t = 0.07$ eV. (auth)

40999 (UUIP–646) PUNCH THROUGH EFFECTS IN EVAPORATED METAL SEMICONDUCTOR CONTACTS. Andersson, L.-P.; Berg, S.; Boonthanom, N.; Garcia Pacheco, O. M. (Uppsala Univ. (Sweden). Inst. of Physics). June 1969. 17p. Dep.

The influence was studied on the functioning of surface barrier detectors with evaporated back contacts. The possible effects of an injecting contact were overlooked. It is shown that it is essential to have a noninjecting back contact if the detector is to be fully depleted in order to obtain the best possible resolution. The investigations were made using detectors having a front contact of Au and a back contact of Al or Au. It was found that freshly evaporated Al contacts were non-injecting, whereas Au contacts were injecting. (auth) (SWEDEN)

41000 (UUIP–649) PLASMA EFFECTS FOR α PARTICLES AND ^{16}O IONS IN SILICON DETECTORS. Tove, P. A.; Seibt, W.; Sundstroem, K. E. (Uppsala Univ. (Sweden). Inst. of Physics). May 1969. 19p. Dep.

Injection of strongly ionizing particles such as α-particles and oxygen ions into semiconductor detectors give rise to plasma effects which change the simple picture of charge collection valid for lightly ionizing particles, e.g., protons. The observable current pulse in the detector therefore becomes different in the mentioned three cases. Measurements results are compared with a previously designed theoretical model which assumes that erosion of the created plasma is caused by transient space charge limited currents from the plasma edge. (auth)

41001 AZIMUTHAL TELESCOPE FOR COSMIC-RAY REGISTRATION. Kabardin, O. F.; Kabardina, S. I.; Kashirina, A. A.; Koifman, M. I.; Mikhailichenko, A. V.; Danilova, V. N.; Sankova, L. A.; Yakovleva, A. M.; Ivanov, V. A.; Brovchenko, M. V. Kosm. Luchi, No. 10, 142-8(1969). (In Russian).

A description is given of an instrument for recording intensity variation of cosmic rays falling vertically and from opposite azimuths at an effective angle of 38° to the vertical. The statistical 1-hour error of the instrument is equal to 0.26% and 0.4% respectively for the vertical and the inclined directions. (auth)

41002 WALL EFFECT IN CYLINDRICAL DETECTORS. Kocharov, G. E.; Petrov, V. V. Kosm. Luchi, No. 10, 167-76 (1969). (In Russian).

A method for calculating the wall effect is offered which is good for cylindrical detectors (ionization chambers, proportional counters). Five-digit tables of the functions $f\ (K_\theta)$ and $\varphi\ (K_\theta)$ are given. (K_θ is the ratio of the range of a particle to the counter diameter.) The tables allow a precise calculation of the differential spectrum distortions due to the wall effect. The calculation method is described in detail and exemplified. (auth)

41003 INSTALLATION FOR MEASURING ULTRAMICROQUANTITIES OF THE RADIOACTIVE ^{37}Ar. Barabanov, I. R.; Veshnikov, V. B.; Pomanskii, A. A. Kosm. Luchi, No. 10, 12-13(1969). (In Russian).

Peculiarities of the design of an installation and techniques for measuring ultramicroquantities of radioactive ^{37}Ar are described. (auth)

41004 PREVENTION OF ACCIDENTAL COINCIDENCE IN A GENERAL-PURPOSE TELESCOPE OF A COSMIC-RAY STATION. Blokh, Ya. L.; Kapustin, I. N. Kosm. Luchi, No. 10, 14-16(1969). (In Russian).

A general scheme is provided for a reliable prevention of accidental coincidences in a general-purpose telescope of a cosmic-ray station. (auth)

41005 AZIMUTHAL TELESCOPE ON PROPORTIONAL COUNTERS FOR UNDERGROUND COSMIC-RAY RECORDING. Blenaru, D. Kosm. Luchi, No. 10, 30-2(1969). (In Russian).

A project of an azimuthal telescope for underground investigations is described. A block diagram of the electronics is presented, schemes of directions parallel to the large-size proportional counters SGM-14 are calculated. (auth)

41006 LARGE-SIZE NEUTRON COUNTERS FOR SUPER MONITORS. Blokh, Ya. L.; Dorman, L. I.; Koyava, V. K.; Leonov, V. Kh.; Chaikovskii, V. G.; Narziev, Kh. Kosm. Luchi, No. 10, 25-6(1969). (In Russian).

The design and some characteristics of the CHM-15 large-size neutron counters (length 2,000 mm, diameter 150 mm) are described. (auth)

41007 EXPERIMENTAL TECHNIQUES IN COSMIC-RAY VARIATIONS STUDY. Leonov, V. Kh.; Blenaru, D. Kosm. Luchi, No. 10, 23-4(1969). (In Russian).

Transistorized low input-resistance cascades are suggested to be used as proportional counter amplifiers. (auth)

41008 METHOD FOR CALIBRATION OF A HIGH-PRECISION NEUTRON SUPER MONITOR. Kapustin, I. N. Kosm. Luchi, No. 10, 33-5(1969). (In Russian).

An improved method of a high-precision neutron super monitor calibration is considered. (auth)

41009 LARGE-SIZE PROPORTIONAL COUNTERS FOR COSMIC-RAY VARIATION STUDY. Blokh, Ya. L.; Blenaru, D.; Dmitriev, A. B.; Dorman, L. I.; Leonov, V. Kh.; Mavlobakhshev, I. Kosm. Luchi, No. 10, 36-8(1969). (In Russian).

Employment of proportional counters for the study of cosmic-ray variations is considered. (auth)

41010 STUDY OF HOMOGENEITY OF LIGHT-COLLECTION FROM A LARGE-AREA PLASTIC SCINTILLATOR. Ivanenko, V. M.; Lukin, Yu. T.; Tsoi, A. Kh. Kosm. Luchi, No. 10, 56-9 (1969). (In Russian).

A large-area scintillator for counting particles in a photon-electronic shower generated by high-energy cosmic radiation is developed. The homogeneity of light-collection from the whole surface of a polystyrene scintillator (dimensions 50 × 50 × 5 cm) is being thoroughly examined when collecting light from the end face. Cosmic μ-mesons of the minimum energy of 280 MeV are used as the probe rays. Some alternative design variants of the detector are considered. (auth)

41011 SPACE-SENSITIVE PARALLEL-WIRE COUNTER SYSTEM. Helfer, H.; Oehmichen, G.; Peter, G. (Technische Univ., Dresden). Kernenergie, 12: 132-3(Apr. 1969). (In German).

The spatial resolution of a Geiger-Müller counter system using two plane rows of counting wires crossing each other has been tested by gamma irradiation ($E_\gamma = 84$ keV). With the xenon-propane gas filling the resolution was better than ±5 mm. (auth)

41012 LOW LEVEL RADIATION MONITOR. Splichal, William F. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,461,292. Filed Nov. 10, 1966.

An improved radiation measuring device for measuring low-level or background ionizing radiation is described. It comprises an ionization chamber circuit, including an electrostatic relay to sense the voltage across the ionization chamber and providing a coupling means between the chamber circuit and a readout circuit, and a by-pass relay means connected to the chamber in parallel with the electrostatic relay. The by-pass relay is energized by a signal from the readout circuit and is adapted to recharge the ionization chamber. This by-pass relay permits an ionization chamber having a relatively large capacitance to be used and will completely recharge the chamber after each counting cycle. (Offic. Gaz.)

41013 A METHOD OF DETERMINING DEAD TIME OF AN X-RAY DETECTING SYSTEM. Fukamachi, Tomoe (Tokyo Univ.). Jap. J. Appl. Phys., 8: 851-4(July 1969).

An improved single-foil method to determine the effective dead time of a pulse-detecting circuit is described. Experimental comparison with other methods showed that a better accuracy was achieved. The present method is also useful for determining accurately the absorption factor of a sample and the attenuation factor of absorbers. (auth)

41014 TREATMENT OF NUMERICAL DATA PARTICULARLY ADAPTED FOR REAL TIME. Friedling, G. (CEN, Cadarache, France). pp 60-112 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).

See CONF-680642.

The theoretical aspect of the treatment in real time of numerical data is presented first from a sufficiently general point of view, then in the framework of certain hypotheses concerning the manner of approaching an optimal form of treatment. (J.F.P.)

41015 DEVELOPMENT OF ELECTRONICS AT CEA. Doireau, M. (CEN, Saclay, France). pp 1-18 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).

See CONF-680642.

The evolution which was produced in nuclear electronics since 1965 is considered without describing the technical details. The work of the Department of Electronics in this field is discussed. (J.F.P.)

41016 NUCLEAR DETECTORS: PHOTOMULTIPLIERS, COMPUTERS, IONIZATION CHAMBERS. Roguin, A.; Weill, J. (CEN, Saclay, France). pp 19–34 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).

See CONF-680642.

The purpose of this report is to give an account of recent work in the field of nuclear detectors other than semiconductor detectors. Essentially the studies and realizations carried out in this domain by the Department of General Electronics during the past years are indicated. This summary permits one to determine the possibilities of these types of detectors and to have a rough estimate of future developments. Neutron–electron converters, counters with boron deposits, counters for recoil protons, fission chambers, G–M proportional counters, and photomultipliers are presented. (tr-auth)

41017 PARALLEL PLATE DYNODE ELECTRON MULTIPLIER: THE METHOD OF PRODUCTION AND ITS CHARACTERISTICS. Konno, Tadashi; Kanayama, Michio (Tohoku Univ., Sendai). Shitsuryo Bunseki, 17: 629-38(June 1969). (In Japanese).

An easy method of making a parallel-plate electron multiplier, which is used for detection of x rays, electron beams, and charged particles, is developed. The multiplier consists of two continuous dynodes, which are prepared by evaporating aluminum onto glass substrates on which carbon has been evaporated in advance. The gain is in the range of 10^6 to 10^9, when the applied voltage is 3 kV. Some of the features are quite good linearity of response except for the saturation region, extremely small noise and long lifetime, and ease in handling. It also can be used for the pulse count techniques. A brief review of the outline of the continuous dynode electron multiplier is added. (NSA of Japan)

41018 THE MEASUREMENT OF THE UNATTACHED FRACTION OF AIRBORNE RaA. Duggan, M. J.; Howell, D. M. (Radiological Protection Service, Sutton, Eng.). Health Phys., 17: 423-7(Sept. 1969).

The significance of the unattached fraction, f, of airborne RaA in assessing the hazard from the inhalation of radon and its daughter products is discussed, and reference made to some of the measurements of f which various workers have carried out in mine atmospheres. A method developed by the authors for measuring f is described. The method entails sampling the atmosphere through a pair of filters positioned side by side. One of the filters is preceded by a diffusion battery designed to remove most of the unattached daughters but hardly any of the attached, and the difference in activities collected on the filters is therefore a measure of the unattached daughter product concentration. Since f is concerned only with RaA atoms it is necessary to distinguish the α-activity on the filters due to RaA from that due to RaC′; this distinction was made by α-spectrometry. Furthermore, because of the short-life of RaA on the one hand, and the desire for high sensitivity on the other, it was found necessary to measure the activity while sampling was in progress. The method was used to measure f in the open air and it was found that only when both f and the RaA concentration are unusually low does the sensitivity become inadequate for a meaningful determination of f. (auth) (UK)

41019 THE STATISTICAL BEHAVIOR OF THE SCINTILLATION DETECTOR: THEORIES AND EXPERIMENTS. Donati, S.; Gatti, E.; Svelto, V. (Laboratori CISE, Milan). Advan. Electron. Electron Phys., 26: 251-307(1969).

The statistical theory of the scintillation detector is described including statistical background, Euling theory, the bivariate generating function, and the statistical equivalent circuit of the scintillation counter. Also, amplitude distribution, time measurements with scintillation detectors, and pulse shape discrimination are discussed. (44 references) (W.H.K.)

41020 SEMICONDUCTOR POSITION-SENSITIVE DETECTORS. Chwaszczewska, Janina; Krogulski, Tadeusz; Tys, Jan (Inst. for Nuclear Research, Swierk, Poland). Nukleonika, 14: 11-15(1969).

Silicon surface-barrier detectors for recording both the position and the energy of incident charged particles were developed. The resolution relative to the position is better than 1 mm, and the linearity of the signal is about 1%. An almost 100% registration efficiency was achieved on the whole length of the diode. (auth)

41021 RECENT ADVANCES IN INSTRUMENTATION FOR URANIUM SEARCH. Stewart, J. R. pp 1-11 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16–21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.

See CONF-680654.

Several new techniques which may be applied with advantage to the search for uranium are described. Scintillation type gamma spectrometers are now available for airborne, ground and borehole use. These can distinguish in a broad way between anomalies due to uranium, thorium and potassium. Gamma spectrometers based on semiconductor detectors now under development should be capable of much greater resolution. These should also make possible rapid, accurate and cheap radiometric analyses of samples containing uranium and/or thorium, whether in radioactive equilibrium or not. Another valuable prospecting aid, particularly in areas of tropical leaching, is systematic sampling of soil for radon content. Equipment for this purpose is currently available and it will be possible to extend the method when development of an alpha probe suitable for use in deeper holes is completed. Variations in the concentration of certain trace elements in soil (e.g., mercury) also offer promise in the search for mineralized zones which may contain economic concentrations of uranium. (auth) (Australia)

41022 EVAPORATED SILVER BROMIDE AS AN ION AND PARTICLE DETECTOR. Masters, J. I. (Technical Operations Inc., Burlington, Mass.). Nature (London), 223: 611-13(Aug. 9, 1969).

It is possible to produce radiation sensitive thin films (0.2 to 0.6μ) of pure AgBr by vacuum evaporation. The use of such films for particle beam detection is discussed. Comparisons are made with the universally used AgBr gelatine emulsions. It is stated that the films may be particularly suitable for particles such as large organic ions and also for low energy electrons, that have a small penetrating range in gelatine. Vapor deposition of AgBr involves some decomposition in the melt, producing gaseous bromine, which reduces detection sensitivity if absorbed in the evaporated layer; outgassing of the surface at 150° to 200°C, however, restores sensitivity. Unbounded or "infectious" silver formation is controlled by use of an "internal" developer containing a AgBr solvent. The modulation transfer function is discussed. The "fog" level is stated to be very low. "Flare" is also discussed. (UK)

41023 MEASUREMENT OF A GAMMA RAY BY A DETECTION CHAIN. Jacot, J. (Laboratoire Central de l'Armement, Arcueil, France). Radioprotection, 4: 17-41(1969). (In French).

The process of the detection of a gamma ray by a measuring apparatus is analyzed, and the form of the obtained data from the output of the apparatus is discussed. The calibration of the detection chain is considered. The methods of analysis of the momentum spectra of a polyenergetic discrete radiation and a continuous radiation are described using an inorganic crystal scintillator as an example. (tr-auth)

41024 THE CALCULATION OF COLLIMATORS FOR SCINTILLATION COUNTERS ESPECIALLY MULTI-APERTURE-COLLIMATORS. Schumacher, Gerd (Technische Hochschule, Aachen. Kernforschungsanlage, Juelich, Ger.). Atomkernenergie, 14: 283-92(July-Aug. 1969).

The gamma-retina as well as other modern apertures designed to delineate a radioactive distribution in visual form uses the multi-aperture-collimator in connection with scintillation counters as stationary detector device. The multi-aperture-collimator is composed of a great number of single collimators. The calculation of the geometric efficiencies, the width at half maximum and the detector response, which determine sensitivity and resolution of the detector, are discussed. For the multi-aperture-collimator an operating range is defined. The calculations are valid for tall collimators and low gamma ray energy. (auth)

41025 TRANSISTORIZED CIRCUITS FOR THE FAST COINCIDENCE EXPERIMENTS. Fukunaga, Kiyoji; Matsuki, Seishi; Fujiwara, Noboru; Miyanaga, Toshihiro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 47: 83-96(Mar. 1969).

The transistorized fast coincidence circuits used with solid state detectors are described. Circuits include the preamplifier, linear amplifier, discriminator, coincidence circuit, linear gate circuit, pulse stretcher, and power sources. (W.H.K.)

41026 CRYOGENIC GAS COUNTING APPARATUS. Schell, William Raymond (to Secretary of the Air Force). U. S. Patent 3,456,701. Filed Oct. 29, 1965.

A counter for measuring radiation is described wherein a radioactive gas is introduced into a chamber which has an opening sealed by a membrane, the central portion of which is in partial contact with a cold surface of a cryostat assembly. This causes the radioactive gas to form a condensate on the cooled portion of the membrane, and means are provided for measuring the radiation from the condensate. (Offic. Gaz.)

41027 SHALLOW LEVEL TRAPPING AND DETRAPPING IN Si(Li) DETECTORS AT LOW TEMPERATURES. Martini, M.; McMath, T. A. (Chalk River Nuclear Labs., Ont.). Appl. Phys. Lett., 14: 374-6(June 15, 1969).

Trapping-detrapping pulse shapes have been observed in two Si(Li) detectors in the temperature range 8.5–70 K. A semiquantitative treatment leads to the conclusion that shallow trapping levels are responsible for the observed phenomena. It appears likely that these levels correspond to the donor (Li) and acceptor (B) dopants; if this hypothesis is confirmed by further experimental work it establishes a low-temperature limit on the use of semiconductor detectors for γ-ray and high-energy particle spectroscopy. (auth)

41028 WALL-LESS DETECTOR FOR MEASURING ENERGY DEPOSITION SPECTRA. Glass, W. A.; Braby, L. A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res., 39: 230-40(Aug. 1969).

Present methods of measuring energy deposition spectra in irradiated media are due to H. H. Rossi and his co-workers. The technique involves simulating microscopic absorption sites in an irradiated medium by cavities filled with a gas of the same atomic composition as the cavity wall. Recent observations indicate that subtle and theoretically intractable errors result because of the presence of the density change at the boundary between the cavity and its wall. A spherical proportional counter design that permits the solid-gas interface to be removed from the vicinity of the active region of the detector is described. Its design, collecting volume geometry, and performance are discussed. The energy deposition spectrum for a broad beam of 4.5 MeV alpha particles is presented. (auth)

41029 SPACE CHARGE EFFECTS IN PROPORTIONAL COUNTERS. Hendricks, Robert W. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 40: 1216-23(Sept. 1969).

The space charge in a gas filled proportional counter resulting from the slowly moving positive ions as they drift from the central wire toward the outer shell is known to cause a significant change in the position and breadth of the energy peak created by monoenergetic x rays. A quantitative theory for the mean shift is developed and confirmed experimentally. (auth)

41030 SITUATION AND THE PERSPECTIVES OF THE DEVELOPMENT OF HUNGARIAN RADIOISOTOPIC DIAGNOSTIC EQUIPMENTS. Ambro, Peter (Gamma Muevek, Budapest). Atomtech. Tajek., 11: 684-6(Dec. 1968). (In Hungarian).

Descriptions of different instruments are presented. (auth)

41031 AN INVESTIGATION INTO THE CAUSES OF THE AGING PHENOMENA OF SELF-QUENCHING GEIGER–MUELLER COUNTER TUBES; C_2H_5CN A BETTER QUENCH GAS THAN C_2H_5OH. Lox, F. E.; Eeckhaut, Z. (State Univ., Ghent). Rev. Sci. Instrum., 40: 1206-9(Sept. 1969).

The decrease of the quenching agent found in aged counters (approximately 2×10^8 counts registered) is of the order of 0.5%. This cannot account for their bad functioning. Only changes on the anode surface (polymer deposit) and in the gas phase (new products formed by counter discharge) are responsible for the deterioration of aged self-quenching G-M counters. The first mentioned changes are neutralized by simply glowing the wire, the latter may be overcome by the choice of a suitable quenching agent. C_2H_5CN gives better results than C_2H_5OH. (auth)

41032 DETECTION OF METASTABLE ATOMS AND MOLECULES WITH CONTINUOUS CHANNEL ELECTRON MULTIPLIERS. Donnelly, Denis P.; Pearl, John C.; Heppner, Richard A.; Zorn, Jens C. (Univ. of Michigan, Ann Arbor). Rev. Sci. Instrum., 40: 1242-3(Sept. 1969).

The use of continuous channel electron multipliers for detection of thermal beams of metastable helium, neon, argon, krypton, xenon, and molecular nitrogen is reported. Although the yield of Auger electrons per metastable incident on the multiplier cathode was not measured, the yield was judged to be comparable to that achieved on the tungsten or platinum surfaces used in the conventional Auger detectors. The detection efficiency for a given metastable species is shown to remain within 10% or so of an equilibrium value in spite of the frequent exposure of the multiplier to humid air and backstreaming pumps vapors. (B.G.D.)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 40610, 40797, 41117, 42382, and 42962.

41033 (CEA-R-3805) X SPECTROMETRY WITH PULSE DETECTORS. Friant, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 28p. (In French). Dep. CFSTI (U. S. Sales Only).

A comparison is made of various types of pulse x-ray detectors [scintillators + photomultipliers, proportional counters, ionization chambers, and semiconductor detectors: Si(Li) and Ge(Li)] as well as of their associated electronic equipment, from the point of view of the resolving power, the detection efficiency, and the working surface, for photons of from 100 eV to 100 keV. Semiconductor detectors (Si(Li) up to 50 keV, Ge(Li) from 10 keV up to 100 keV) should rapidly find uses in all cases where an excellent resolving power is necessary (in x-fluorescence for example). Proportional counters present greater advantages for applications calling for a high detection surface, and also for very soft x-rays because the window of the detector can be very thin. (auth)

41034 (EUR-4289, pp 21-34) FET PREAMPLIFIERS FOR SEMICONDUCTOR RADIATION DETECTORS. Elad, Emanuel (Nuclear Diodes, Inc., Prairie View, Ill.).

A summary of the state-of-the-art of FET preamplifiers for x-ray and γ-ray spectroscopy is presented. Mainly noise considerations for cryogenic operation are analyzed, both from the device and circuit point of view. A comparison is made between various types of FET's differing in channel material, geometrical structure and operating conditions. Some previously unpublished results on GaAs FET's are given. The noise of the input stage and especially its temperature dependence is analyzed and some optimum measuring conditions are derived. Input stage configurations, detector-preamplifier coupling methods and microphonic generation are discussed, emphasizing low temperature operation. Finally, future possibilities in the development of low noise amplifiers are assessed in view of the growing scientific and industrial applications of high resolution semiconductor spectrometers. (auth)

41035 (EUR-4289, pp 35-41) THE DEVELOPMENT OF "n" CHANNEL FET'S FOR LOW NOISE NUCLEAR PULSE AMPLIFIERS. Howes, J. H. (Atomic Energy Research Establishment, Harwell (England)).

Some aspects of the development and characteristics of two types of low noise n channel field-effect transistors developed on U.K. government contracts, placed by the C.V.D. organization on Texas Instruments Ltd., Bedford, England, and supervised by A.E.R.E. Harwell are discussed. The transistors were developed to meet a general circuits requirement for high input impedance, low noise transistors for following nuclear particle detectors, infrared detectors and acoustical transducers. The application of the transistors to the design of low noise pulse amplifiers for very high resolution nuclear particle and gamma-ray spectrometry is described. (auth)

41036 (EUR-4289, pp 47-54) MINIMUM-NOISE FILTERS WITH GOOD LOW-FREQUENCY REJECTION. Deighton, M. O. (Atomic Energy Research Establishment, Harwell (England)).

A nuclear pulse spectrometer should have both low noise and minimal sensitivity to slow disturbing signals, e.g., base-line fluctuations due to long CR-couplings. A bipolar filter weight-function (or step response) with area balance is advantageous for the latter, but generally involves increased noise and/or resolving time. The optimum area-balanced waveform giving least noise for a defined overall width is derived. Optimum waveforms are illustrated and the noise/signal performance is compared with that of the finite-width unipolar cusp and also with several practical bipolar systems in common use. (auth)

41037 (EUR-4289, pp 55-66) MISMATCH ORIENTED CIRCUIT DESIGN AND ITS APPLICATION TO NUCLEAR ELECTRONICS. Arbel, Arie F. (Technion-Israel Inst. of Tech., Haifa).

Consistent application of mismatch between source and load is shown to lead to the design of feedback amplifiers, whose characteristics closely approach those of idealized black boxes exhibiting zero or infinite input and output impedance levels. The resulting configurations are shown to employ enhancing combinations between four kinds of basic amplifiers and series or shunt feedback applied to their input and output, respectively. Depending upon the signal parameter employed, the input and output terminals of the black boxes will operate in the voltage or in the current mode, each emerging in its own rights as the preferable technique if employed under proper conditions. Enhancing combinations result in greater flexibility of usable gain values and functions, and in reduced noise contribution to the preceding stage. Further extension of mismatch to active circuit design makes it possible to employ a greatly simplified transistor model, and restricts the dominant poles to those which are unavoidably introduced by the active elements. The resulting standard circuits are readily reproducible by conventional manufacturing methods, and further improvement of their performance is predicted through the application of microcircuit techniques. The design of a high resolution spectrometer is described, which employs enhancing combinations of such standard circuits. The choice of the most suitable circuit for each stage depends on the preferred signal parameter, noise considerations, and gain requirements. (auth)

41038 (EUR-4289, pp 111-17) TIME-OF-FLIGHT INSTRUMENTATION FOR A QUASIELASTIC CRITICAL NEUTRON-SCATTERING EXPERIMENT. Christiansen, E. Mose; Christensen, Palle (Danish Atomic Energy Commission, Risoe. Research Establishment).

The instrumentation for a quasielastic critical neutron time-of-flight experiment is described. On the basis of an experiment using a sinusoidal modulating chopper and a position-sensitive neutron detector, a combined time-of-flight and scattering-angle analysis is performed by means of a 1024-channel analyzer. A digital delay generator delays the phase reference pulses from the chopper for a period equal to the mean flight time of the neutrons. As this may be much longer than the time separation between the reference pulses a special working principle was required. The delay generator and the changes made in the standard pulse-height analyzer to perform the position- and the time-of-flight analysis are described in detail. (auth)

41039 (EUR-4289, pp 141-8) SYSTEM REQUIREMENTS FOR HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY AT HIGH COUNTING RATES. Heath, R. L.; Johnson, L. O. (Idaho Nuclear Corp., Idaho Falls).

The full potential of high-resolution gamma-ray spectrometers has been severely hampered by degradation in the quality of the pulse-height spectrum at high input data rates. Over the past year or two considerable effort has been expended in the examination of this problem. The nature of these instrumental difficulties, realistic experimental requirements, and state-of-the-art solutions to these problems are reviewed. A dc-coupled system which has been developed for high-rate applications is described and the performance presented. (auth)

41040 (EUR-4289, pp 171-8) PERFORMANCE TESTS FOR Ge(Li) SPECTROMETERS. Meyer, H.; Verelst, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

Test equipment for the simulation of experiment conditions was developed to simplify the design and to standardize the test of high precision instrumentation for spectrometers in the future. For linearity, stability and resolution tests an electronic precision pulse generator has been developed which allows an almost perfect simulation of detector signals and a measurement accuracy, better than 0.01%. A random generator for the simulation of Compton continua is described which has been applied together with the precision pulser for high rate performance tests of a spectrometer. In such a way experiment conditions were simulated without the need of detectors and radiation sources. Suitable detector tests are also desirable to reach an optimum overall response of a spectrometer. For comparison, high rate measurements of a spectrometer, designed earlier and equipped with additional fast circuits to reduce pile-up effects, has been performed up to input rates of 3.10^5 cts/sec; ^{60}Co γ-rays detected with a planar detector and the simulated spectrum of the 1.33 MeV line were applied for that purpose. (auth)

41041 (EUR-4289, pp 221-3) ANALOG SPECTRUM STABILIZER. Friese, Thomas (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)).

An analog spectrum stabilizer with digital memory for the error signal is described. A peak or slope of the spectrum is used as reference. External gain drift will be totally compensated by controlling the gain of an amplifier, whose feedback loop partly consists of FET's working as VCR's. (auth)

41042 (EUR-4289, pp 259-61) MULTIPARAMETER ANALYSIS AND RECORDING SYSTEM (MARS) FOR ISOTOPES IDENTIFICATION OF TRANSURANIUM ELEMENTS. Fefilov, B. V.; Chelnokov, L. P. (Joint Inst. for Nuclear Research, Dubna (USSR)).

Multiparameter analyzer for experiments on search and identification of alpha-radioactive isotopes of far transuranium elements produced by bombarding targets with heavy ion-beams on the 310-cm cyclotron of JINR is described. The analyzer was intended for data acquisition and accumulation by five parameters: an energy and a half-life of the original nucleus, an energy and a half-life of a daughter nucleus and the number of a detector. Moreover, the analyzer has special control units for performing an experiment. There are four alpha-spectrometers with semiconductor detectors, stabilization system and a common ADC on 2000 channels. (auth)

41043 (EUR-4289, pp 349-53) STATISTICAL ERRORS OF DIRECT PULSE RATE RATIO MEASUREMENT. Konrad, M. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)).

Some digital and analog methods for direct rate ratio measurement of random pulses are considered and compared with respect to their figure of merit. It is shown that for completely random pulses the considered methods have the same figure of merit excluding the bistable method, whose figure of merit is smaller by a factor of 2. The analog method is given, whose realization is not so simple as that of the bistable method, but its figure of merit is the same as for other methods. (auth)

41044 (EUR-4289, pp 375-8) A METHOD FOR THE ANALYSIS OF COMPLEX GAMMA-RAY SPECTRA USING A COMPUTER. Inouye, Tamon (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Kanagawa Prefecture (Japan). Central Research Lab.).

A computer method is developed for the analysis of complex gamma-ray spectra obtained by the Ge(Li) detector. The computer code by this method carries out smoothing, background subtraction and peak sorting of the multichannel pulse height distribution. By applying this method, 800 channel pulse height distributions of gamma-ray spectra have been analyzed. (auth)

41045 (IN-1287) DATMON: A PDP-9 COMPUTER PROGRAM FOR THE SIMULTANEOUS ACQUISITION OF DATA FROM ONE NEUTRON TIME-OF-FLIGHT SPECTROMETER AND ONE NEUTRON TRIPLE-AXIS CRYSTAL SPECTROMETER. A USER'S MANUAL. Myers, W. R. (Idaho Nuclear Corp., Idaho Falls). July 1969. Contract AT(10-1)-1230. 78p. Dep. CFSTI.

The time-of-flight and triple-axis Data Monitor is a set of interacting PDP-9 computer programs which will control the simultaneous acquisition of data from one time-of-flight neutron spectrometer and one neutron triple axis crystal spectrometer. This report is primarily intended to be a user's manual for the Data Monitor; although a few pages are devoted to programming philosophy and discussion of program operation, the emphasis is on the 50 keyboard commands available to the experimenter for the control of his experiment. (auth)

41046 (ORNL-TM-2675) NEUTRON INDUCED BACKGROUND EFFECTS IN GAMMA-RAY SPECTROMETERS FOR USE IN SPACE. Macklin, R. L. (Oak Ridge National Lab., Tenn.). Aug. 12, 1969. Contract W-7405-eng-26. 16p. Dep. CFSTI.

An introduction to neutron shielding problems for a gamma-ray spectrometer operating in the upper atmosphere or in space is given. Attention is focused on gamma-ray background production from 50 keV to a few MeV, the region where characteristic nuclear gamma-ray lines are found. A specific example of a spectrometer shield was designed, constructed, and tested for effectiveness with pulsed neutrons. (auth)

41047 SCINTILLATION SPECTROMETER FOR THE DETERMINATION OF THE MASS VALUES AND THE ENERGY SPECTRA OF ELEMENTARY PARTICLES. Khrimyan, A. V.; Koshtoev, V. V.; Petrosyan, M. L.; Karapetyan, V. A.; Kazaryan, S. S.; Avetyan, B. A. Kosm. Luchi, No. 10, 124-7(1969). (In Russian).

A scintillation spectrometer is described which has been developed for method analyses in design of high-transmission instruments to be used in the study of cosmic radiation and in acceleration techniques. The theoretical background of the spectrometer and its operational block-diagram are presented. (auth)

41048 AN INEXPENSIVE TRIPLE-AXIS NEUTRON SPECTROMETER. Pawley, G. S. (Univ. of Edinburgh). J. Appl. Crystallogr., 2: 37-9(1969).

A simple design is suggested for a triple-axis neutron spectrometer. Although the instrument does not have the flexibility of sophisticated machines, it is capable of the measurements required by most phonon problems. As it has only one working configuration it should be very simple to use. The basic design problem of these instruments is the control of a heavily shielded counter at the extremity of three variable arms. In the suggested instrument the counter is free only to rotate about the vertical. Support and control of the heavy shielding is, therefore, much simplified. The geometry is altered by varying the lengths of two of the arms, which is possible to high accuracy. (auth)

41049 DATA PROCESSING FOR A GAMMA SPECTROMETER. Boulanger, J. P. (CEN, Saclay, France). pp 135-80 of Proceedings of the Third International Meeting on Electronics

and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).
See CONF-680642.

Numerical calculations for the processing of gamma spectrometer data are described. The analysis of total absorption peaks, decomposition of a complex spectrum, spectra production, biparametric analysis, and the decay scheme of ^{110m}Ag are discussed. (J.F.P.)

41050 ACQUISITION SYSTEM AND PROCESSING OF NUCLEAR DATA. Barthelemy, M. M. (CEN, Saclay, France). pp 181-200 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).
See CONF-680642.

The discussion of acquisition systems for processing numerical data covers numerical calculations in analysis chains, purposes of the system studied, arrangement of the system, and programing for the system. (J.F.P.)

41051 COMPUTER SYSTEM FOR PSEUDO-RANDOM TRANSFORMATION OF NUCLEAR DATA. Soucek, B.; Bonacic, V.; Culjat, K.; Radnic, I. (Inst. Rudjer Boskovic, Zagreb). pp 333-47 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968.
See CONF-680642.

It is shown that many problems in nuclear pulse spectrometry fall in the common field of digital, analog, or time transformation of stochastic processes. Digital transformation is applied on-line to each event (descriptor). Passing through a transformation box, each descriptor produces a pseudo-random address into which it is stored. Transformation is similar to error correction by using coding theory. It comprehends scattered multidimensional physical spectrum into minimal space, enabling high speed on-line million-channel spectrometry. Analog transformation is the basis of random nuclear processing. A software package is developed which makes fast solution of problems such as signal shaping, noise filtering, pile-up, etc., for practically any signal, noise, rate, and circuitry combination of interest. Time transformation occurs when random pulses pass through circuitry with time memory. It is found that Poisson distribution is transformed into a broad class of usable distributions. The results obtained are used to design the computer system for extraction of the maximum amount of information. The system consists of two computers, PDP-8 and C 90-40 (SDS-930), light pen, digital spectrum stabilizer, 4096 channel ADC etc. (auth)

41052 PRIKLADNAYA STSINTILLYATSIONNAYA GAMMA-SPEKTROMETRIYA. (Applied Scintillation Gamma Spectrometry). Matveeva, V. V. (ed.). Moscow, Atomizdat, 1969. 464p.

The design of improved scintillation γ spectrometers is described. Gamma spectra measured by means of polycrystalline scintillation spectrometers always contain components of total absorption. The causes inducing total absorption were analyzed and recommendations are made for eliminating the parasitic effects or for using them for constructing γ spectrometers of total coincidences and spectrometers with total absorption peaks. A supplementary chapter contains tabulated data on the recording efficiency of γ radiation for NaI(Tl) and Cs(Tl) crystals calculated by a geometric similitude method. 149 references are included. (R.V.J.)

41053 AN ADAPTED MODEL FOR THE LET DEPENDENCE OF LiF THERMOLUMINESCENCE. Davy, D. R.; O'Brien, B. G. (Australian Atomic Energy Commission, Sutherland, New South Wales). Health Phys., 17: 471-82(Sept. 1969).

Available evidence indicates that the trapping centers of TLD LiF involve complexes of Mg^{2+} ions and vacancies in the host crystal. Many points of similarity between the LET dependence of the thermoluminescence process and that of the luminescence of Tl^{+} activated alkali halides must therefore exist, and models previously developed for the latter should be applicable to the former. An adoption of the activation saturation model of scintillator response to the LET dependence of TLD LiF is presented. On comparing the predictions so obtained with experimental results following neutron irradiations, a reasonable fit results only if at least one of the trapping sites has a LET dependent hole capture cross section. (auth) (UK)

41054 STATISTICAL TIME-OF-FLIGHT METHOD FOR STRUCTURE INVESTIGATIONS WITH SLOW NEUTRONS. Glaeser, W.; Gompf, F. (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 12: 153-9(May 1969). (In German).

The basic principles of the pseudostatistical, or pseudorandom, time-of-flight method for measuring reactor dynamic parameters are outlined. Use of a spectrometer for these measurements is discussed; construction and operation of the spectrometer are described. Calibration procedures for the instrument are summarized; some typical calibration curves are shown. (M.L.S.)

41055 SYSTEM FOR MEASURING SPECTRA AND ENERGY DEPENDENCE IN NUCLEAR REACTIONS. Bochkarev, V. N.; Volkov, A. N.; Klabukov, A. M.; Musaelyan, R. M.; Shtranikh, I. V. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 109-13(Jan. 1969). (In Russian).

Study of neutron scattering near the excitation threshold of the lower level of nuclei requires a considerable reduction of errors in the measurement of the background and in the drift of the instrumentation. Application of a supplementary accelerating potential on the target helps to reduce these errors. The potential may change continuously in a seesaw fashion with an amplitude up to 150 kV and a frequency of 50 Hz. The spectra represent the multidimensional probability distribution of events, i.e., the number of recorded γ quanta of a given energy in the neutron energy function. The potential was generated by an electronic system, adding to the basic 50-Hz sinusoidal voltage the 3rd, 150 Hz and the fifth, 250 Hz harmonics. The amplitude of the γ quantum pulses passing through the spectrometric system were encoded, and ultimately recorded in binary form. The system may be remotely operated by means of telephone cables. The overall system with a magnetic drum is very flexible and allows a convenient organization of the recorded data. (TTT)

41056 DETERMINATION OF THE LOCATION OF THE FOCAL SURFACE IN A WIDE-RANGE MAGNETIC SPECTROGRAPH. Malakhov, I. Ya.; Deineko, A. S.; Kovalenko, A. I. (Physical-Technical Inst., Kharkov). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 120-2(Jan. 1969). (In Russian).

In order to be able to use the formulas derived by C. P. Browne et al. needed to calculate the coordinates of the focal surface of a magnetic spectrograph, certain specific conditions must be fulfilled with respect to the effect radius of the magnetic field boundary and the radius of the poles. Location of the surface may be also determined experimentally by using an α source, an emulsion, a crystal, and a photomultiplier or semiconductor counter. The method required variation of the position of the counter over the scattering surface, determining the location at which the peaks of the spectrum are best resolved. This laborious process may be accelerated by taking into account the geometric relations between the effective radius and the small shifts in the location of the counter. The error in the calculations by means of the derived formulas amounts to a few millimeters and it does not exceed the error arising from the approximation of the hyperboric surface by means of a series of broken lines. (TTT)

High Energy Physics Instrumentation

Refer also to abstracts 41861, 42541, 42542, 42602, 42640, and 42786.

41057 (CERN-69-18) ON THE QUALITY OF MEASUREMENTS MADE WITH THE HPD MINIMUM GUIDANCE SYSTEM. Ganguli, S. N.; Villemoes, P. (European Organization for Nuclear Research, Geneva (Switzerland)). July 7, 1969. 18p. Dep.

The characteristics and performance of the HPD–Minimum Guidance (MING) program for processing four- and six-pronged events in the CERN 81-cm hydrogen bubble chamber are described. First pass success rates of the events after the kinematical fitting program GRIND, were 65 and 50% for the four-prongs and six-prongs, respectively. Results from these events were compared with an equal number of events (from the same exposure) measured on IEP. (W.H.K.)

41058 (CERN-69-21) SYSTEM APPROACH TO HIGH-SPEED COUNTER LOGIC. Dufournaud, J.; Friend, B. (European Organization for Nuclear Research, Geneva (Switzerland)). Aug. 6, 1969. 26p. Dep. CFSTI (U. S. Sales Only).

A system approach to high-speed counter logic and a practical realization for the study of the $\Delta S/\Delta Q$ rule in K^0 decays is described. Particularly, timing circuits for the coincidence system are discussed. (auth)

41059 (UCRL-19214) WHAT'S NEW AND OLD IN THE RANGE-ENERGY RELATION. Heckman, Harry H. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1969. Contract W-7405-eng-48. 22p. (CONF-690503-4). Dep. CFSTI.

From International Conference on Hypernuclear Physics, Argonne, Ill.

A survey of the developments in the work on the range–energy relation for charged particles in nuclear emulsions is presented. (W.H.K.)

41060 ON POSSIBLE EXPERIMENTAL OBSERVATION OF NEUTRINOS FROM COLLAPSING STARS. Domogatskii, G. V.; Zatsepin, G. T. Kosm. Luchi, No. 10, 139-41(1969). (In Russian).

It is shown that an installation containing several tons of the detector substance (such as CH_2 or ^7Li, ^9Be) can be used to record a series of positrons or electrons from the reactions $\bar{\nu} + p \rightarrow n + e^+$ or $\nu + z \rightarrow (z + 1) + e^-$ induced by antineutrino–neutrino fluxes from the collapsing stars of our Galaxy. (auth)

41061 SOLAR NEUTRINO DETECTION BY MEANS OF RECORDING ELECTRONS IN REACTIONS $\nu + Z \rightarrow (Z + 1) + e^-$. Domogatskii, G. V.; Eramzhyan, R. A. Kosm. Luchi, No. 10, 132-5(1969). (In Russian).

The light nuclei of ^7Li, ^9Be, ^{11}B and a number of other nuclei as possible solar neutrino detectors is examined. Cross sections and angular distributions of electrons were obtained. The conclusion is that only the isotopes of ^9Be and ^{11}B can be used for practical measurement of angular correlations. (auth)

41062 EQUIPMENT FOR THE RECORDING OF SPECTRAL INTENSITY OF HIGH-ENERGY ELECTRONS AND γ-QUANTA. Gorodinskii, G. M.; Romanov, A. M. Kosm. Luchi, No. 10, 116-18(1969). (In Russian).

The requirements to be met by the equipment employed for the recording of electrons and hard γ-quanta in the upper layers of the atmosphere and beyond its boundaries are considered. An instrument is described which consists of three scintillation counters, a spark chamber, a spectrometer shower detector, an electronic system for event sampling, and recording device. The features of these units are specified. (auth)

41063 INSTALLATION FOR THE STUDY OF THE EXTENSIVE SHOWERS AND NUCLEAR INTERACTION OF THE COSMIC RADIATION PARTICLES OF THE ENERGIES $10^{12}/10^{16}$ eV. Erlykin, A. D.; Nesterova, N. M.; Nikol'skii, S. I.; Sokolovskii, V. I.; Tukish, E. I.; Yudin, E. P.; Yakovlev, V. I. Kosm. Luchi, No. 10, 104-15(1969). (In Russian).

A new complex installation at the Tyan-Shan Alpine station (3,340 m above sea-level) is designed for the study of the interaction of the nuclear-active particles and muons with the lead nucleons at energies above 10^{12} eV and of the interaction of nucleons with the nuclei of the atoms of air at energies of $10^{13}-10^{16}$ eV. The design of the installation has been determined by the special requirements extended to the study of the central region of the extensive air showers, the nuclear-active particles and the high-energy muons. The installation includes: (1) large-size ionization calorimeter (surface 36 sq. m) which consists of 14 trains of ionization chambers (96 chambers per train) interlaid with 5-cm lead plates. Between the 1st and the 2nd, and the 6th and the 7th, trains there are placed x-ray film magazines covering the whole surface of the calorimeter. The calorimeter and the films are used for the investigation of the high-energy nuclear-active particles properties. The upper train of the calorimeter is shielded with 2.5-cm thick lead and it will allow the energy characteristics of the photon-electronic component of the showers to be studied. (2) Small-size ionization calorimeter (surface 9 sq. m) is installed under ground at the depth of 11 m under the large calorimeter. It consists of 15 trains of ionization chambers (24 chambers each). The lead layers between the trains will be 2.5 cm and 5 cm thick, depending on the experiment. This calorimeter is intended for the study of the muon component of the cosmic radiation. (3) Neutron supermonitor, placed at 40 m from the centre of the large calorimeter, serves as detector of the low-energy nuclear-active particles in the extensive air showers. It allows to evaluate a complete number of particles in a shower. (4) Central tray of scintillation counters, arranged above the calorimeter and covering the surface of 130 sq. m, consists of 64 scintillation counters, 0.25 sq. m each. This tray will be used to investigate the spatial distribution of the photon-electronic component near the core of the shower and to determine the point where the particles cross the axis and the complete number of the particles in low-power showers. (5) Four scintillation counters, 1 sq. m each, are placed at the corners of a square, 20 m from the centre of the calorimeter. These are used to measure the slope of the shower core. (6) A block of peripheral scintillation counters, covering 16 sq. m, is placed at the distance of 70 m from the centre. It serves to measure the total number N of particles at the observation level in showers with $N > 10^5$. (7) Detectors of the secondary radiation produced by shower particles in the atmosphere are placed at distances of 10, 70, and 180 m from the center of the calorimeter. Multiplier phototubes are used as light detectors; their sensitivity is enhanced with parabolic mirrors 1.5 m in diameter. With the aid of the detectors data on the energy and the nature of showers evolving in the atmosphere will be collected. (auth)

41064 NEUTRINO SPECTROSCOPY OF THE SUN. Zatsepin, G. T.; Kuz'min, V. A. Kosm. Luchi, No. 10, 75-7(1969). (In Russian).

A program of neutrino spectroscopy of the Sun is discussed; two sets of detectors are to be used: (1) ^{71}Ga, ^{37}Cl (or ^{87}Rb), and ^7Li suitable for radiochemistry, and (2) electron detectors in β-process caused by solar neutrinos in the nuclei of ^2D, ^7Li etc., and in the process of neutrino-electron scattering. Detectors of group (2) permit to measure the flux of ^8B neutrinos, and detectors of group (1)—to measure fluxes of pp, ^7Be, and ^{13}N, ^{15}O neutrinos. The radiochemical method with ^7Li is found to be suitable for determination of the effects of the CNO-cycle. The possibilities of using ^7Li as a radiochemical detector are discussed. (auth)

41065 SEMICONDUCTOR DETECTORS FOR NUCLEAR PARTICLES. Messier, J. (CEN, Saclay, France). pp 35-59 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).
See CONF-680642.

The physical principles underlying the operation of semiconductor detectors are recalled, and the most important problems presented by their realization and use are mentioned. (J.F.P.)

41066 A PROPOSAL OF THE METHOD FOR ENERGY MEASUREMENTS OF MUONS OVER 10 TeV. Wada, Tomonori; Kitamura, Takashi (Osaka City Univ.). Progr. Theor. Phys. (Kyoto), 41: 1587-9(June 1969).

A method of determining the energy of high-energy muons is suggested, which is based on the observation of direct electron pair production. For the experimental apparatus, sandwiched layers of lead producers and counters are suggested. The counter may be either a large-area proportional counter or a large area scintillation counter. The incident energy of a muon is determined from the number of produced electron pairs whose pair-energy values fall within a certain energy range. (L.B.S.)

41067 PRACTICAL POSSIBILITIES TO USE GALLIUM AND LITHIUM AS SOLAR NEUTRINO DETECTORS. Pomanskii, A. A. Kosm. Luchi, No. 10, 95-7(1969). (In Russian).

It is shown that $GaCl_3$ and an aquatic solution of LiCl can be used for the solar neutrino detection. The techniques of educing germanium-71 from $GaCl_3$ and beryllium-7 from LiCl generated by reactions $\nu + {}^{71}Ga \rightarrow {}^{71}Ge + e^-$ and $\nu + {}^7Li \rightarrow {}^7Be + e^-$ are discussed. It is also shown that the effect of the background processes may be neglected when necessary decontamination of the detector substances is made. The problems of recording the decay of the radioactive ^{71}Ge and ^7Be are considered. (auth)

41068 POSSIBILITIES OF CALIBRATING NEUTRINO INSTALLATIONS WITH THE AID OF ARTIFICIAL NEUTRINO SOURCES. Kopysov, Yu. S.; Kuz'min, V. A. Kosm. Luchi, No. 10, 87-9(1969). (In Russian).

The possibilities of obtaining beams of neutrinos for the purpose of calibrating the experimental methods used in the study of the solar neutrino radiation are discussed. The following methods of neutrino generation are considered: (1) β^+-activation by neutrons from a nuclear reactor in reactions (n,γ), $(n,2n)$; (2) β^+-activation with γ-quanta and electrons in an electromagnetic shower produced by accelerated electrons in processes (γ,n), $(\gamma,2n)$, $(e^{\pm},n)$; (3) β^+-activation with accelerated protons and ions in reactions (p,n), $(^3He,n)$. It turned out that the existing equipment would allow one to obtain the following neutrino current densities at the distance of ~10 m from the source, (1) $\sim (10^{10} + 10^{11})$ cm^{-2} sec^{-1}, $E_\nu \leq 2$ MeV, in case of a reactor, (2) $\sim (10^5 + 10^6)$ cm^{-2} sec^{-1}, $E_\nu = 2.72$ MeV, in case of electron accelerators, (3) $\sim 10^4$ cm^{-2} sec^{-1}, $0 \leq E \leq 16$ MeV, for a proton accelerator. A meson plant could provide for an electronic neutrino flux of $\sim {}^710$ cm^{-2} sec^{-1} with an energy of $0 \leq E_\nu \leq 53$ MeV. The calibration effect in ^{71}Ca and ^{37}Cl detectors in a most favorable case (a reactor, a meson plant) exceeds the solar effect by 10 + 100 times, but still is 100 + 10 times less than the background effects at the sea level and at small underground depths connected with the cosmic radiation. (auth)

41069 MAGNETIC TAPE HOUSE-KEEPING SYSTEM FOR STORING BUBBLE CHAMBER EVENTS. Telbisz, Ferenc. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 171-8(1969). (In Hungarian).

In connection with the bubble chamber event library a magnetic tape house-keeping system is elaborated, which is suitable to handle data of arbitrary origin and store them on magnetic tape in structured form. This system is an extension of the ICL magnetic tape house-keeping system for composite files. Subroutines are worked out for easy sentinel manipulation, as well as for automatic bookkeeping and information protection functions. The subroutines can be found on the Master Library Tape of the KFKI ICL computer. (auth)

Radiation Dosimeters

Refer also to abstracts 41314 and 41315.

41070 (COO-1105-149) WAVELENGTH DEPENDENCE OF PHOTOSTIMULATED TL IN LiF. Pearson, D.; Cameron, J. R. (Wisconsin Univ., Madison. Univ. Hospitals). July 15, 1969. Contract AT(11-1)-1105. 7p. Dep. CFSTI.

Averaged peak heights of the photostimulated thermoluminescent glow curves for lithium fluoride phosphors, corrected for the variation in output of the light source as a function of wavelength, are presented. The photostimulation process includes gamma predose, first heating, uv exposure, and then thermoluminescent measurement. (W.H.K.)

41071 (COO-1105-151) THE SIMULTANEOUS MEASUREMENT OF X-RAY QUALITY AND QUANTITY USING TLD. Ort, Michael G.; Cameron, John R. (Wisconsin Univ., Madison). [nd]. 15p. (CONF-680920-12). Dep. CFSTI.

From 2nd International Conference on Luminescence Dosimetry, Gatlinburg, Tenn.

A method is described for simultaneous determination of both the quality and quantity of a mono-directional x-ray beam using a modified commercial dosimeter consisting of natural CaF_2 phosphor bonded to a metal cylinder. Upon exposure of the dosimeter, the dose received by the side toward the x-ray source (anterior side, A) is different than that of the other side (posterior side, B) due to attenuation and buildup in the metal cylinder. Since this effect would be expected to differ with the effective energy of the beam, a measure of quality of the beam can be obtained if the orientation of the dosimeter during exposure and readout is properly maintained. The thermoluminescent (TL) measurement must be made on a special reader which permits the measurement on the TL from sides A and P separately and simultaneously. (auth)

41072 (TID-25156) THERMOLUMINESCENCE OF LITHIUM FLUORIDE FOR VARIOUS TYPES AND CONCENTRATIONS OF DOPANTS. Cameron, John R.; Orser, Lynn (Wisconsin Univ., Madison). [1964]. Contract AT(11-1)-1105. 20p. Dep. CFSTI.

Lithium fluoride crystals were grown and doped with various dopants, ground to a fine powder, irradiated, and then the thermoluminescence glow curves measured. Dopants used were magnesium, barium, copper, titanium, aluminum, and samarium, and combinations and compounds of these procedures and results are presented. (W.H.K.)

41073 (TID-25158) MILLIROENTGEN MEASUREMENTS WITH LiF. Zimmerman, David; Cameron, John R. (Wisconsin Univ., Madison). [1964]. Contract AT(11-1)-1105. 4p. Dep. CFSTI.

Techniques for using lithium fluoride thermoluminescent dosimeters for measuring irradiation levels below 1 r are briefly discussed. Methods for reducing unwanted photomultiplier tube currents including dark current, black body radiation, thermoluminescence from heater or pan, and non-radiation induced thermoluminescence are described. Thermoluminescence glow curves in the mr range are included. (W.H.K.)

41074 (TID-25159) THERMOLUMINESCENCE EMISSION SPECTRA OF TLD-100 AND 1963 HARSHAW OPTICAL GRADE LITHIUM FLUORIDE. Zimmerman, David; Cameron John R. (Wisconsin Univ., Madison). [1964]. Contract AT(11-1)-1105. 5p. Dep. CFSTI.

The thermoluminescence emission spectra of irradiated powdered lithium fluoride in the range 2000 to 6500 Å were measured. Procedures and results are described. (W.H.K.)

41075 (TID-25160) DETERMINATION OF TRAP DEPTHS AND FREQUENCY FACTOR FOR TLD-100 AND 1963 HARSHAW OPTICAL GRADE LiF USING ISOTHERMAL DECAY OF THERMOLUMINESCENCE. Zimmerman, David. Cameron, John R. (Wisconsin Univ., Madison). [1964]. Contract AT(11-1)-1105. 19p. Dep. CFSTI.

Electron trap energy depths and frequency factors were determined for lithium fluoride thermoluminescent dosimeters by measuring the decay of the thermoluminescence glow peak at two different temperatures. Procedures and results are presented. (W.H.K.)

41076 THERMOLUMINESCENT DOSIMETRY FOR PERSONAL MONITORING OF URANIUM MINERS. McCurdy, David E.; Schiager, Keith J.; Flack, Edwin D. (Colorado State Univ., Fort Collins). Health Phys., 17: 415-22(Sept. 1969).

An accurate dosimetry system using thermoluminescent detectors was developed for monitoring radiation exposures to individual uranium miners. The system permits the evaluation of cumulative exposures to airborne radon progeny, expressed in units of Working Level Months, as well as the external gamma-ray exposure originating from the ore bodies. Thermoluminescent materials such as LiF, $CaF_2:Dy$ and $CaSO_4:Mn$ were evaluated as possible alpha-sensitive detectors of radon progeny collected on a filter paper. The most promising TLD utilizes $CaF_2:Dy$, and is sufficiently sensitive to detect the accumulation of 10^5 MeV of latent alpha energy collected on a filter paper. Proper annealing of the $CaF_2:Dy$ crystal provides two response peaks, at 185°C and 265°C, for which fading is negligible for any proposed monitoring period. (auth) (UK)

41077 CONTROLLED DEFECT COLORATION DOSIMETER. Muller, Albert C. (to United States Atomic Energy Commission). U. S. Patent 3,453,430. Filed Jan. 5, 1968.

A low dose coloration dosimeter useful in the range up to 10^5 rads consisting of fused quartz having radiation induced lattice defects from which the trapped charge carriers have been removed by heating is described. By the ionization mechanism the carriers are returned upon exposure to radiation. The number of carriers returned is measured by coloration and is an indicator of the dose of radiation received. (Offic. Gaz.)

41078 PORTABLE ELECTROSCOPE TYPE DOSIMETER. Bryer, Robert George (to R. A. Stephen and Co., Ltd.). U. S. Patent 3,459,940. Priority date, Dec. 1, 1964, Great Britain.

There is disclosed a portable dosimeter of the electroscope type in which an electroscope having a movable member responsive to an electric charge, a translucent member bearing a graticule and a lens system imaging the movable member on the graticule are disposed in optically aligned relationship in a sealed tubular member. An eyepiece for viewing the image is exchangeably insertable into the end of the tubular member adjacent to the translucent member therein so as to engage wall surfaces of the tubular member in sealing engagement. Locating means including mating surfaces are provided for limiting the depth of insertion of the eyepiece into the tubular member to an axial portion in which the eyepiece is focused upon the image of the movable member. Due to the exchangeable mounting of the eyepiece, the same eyepiece can be used for reading any number of dosimeters. As the eyepiece is an expensive component of a dosimeter, the possibility of using the same eyepiece for a plurality of dosimeters represents a considerable saving. (Official Gazette)

41079 CHEMICAL DOSIMETRY WITH TRANS-STILBENE-DOPED POLYSTYRENE FILM. Harrah, L. A. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Res., 39: 223-9(Aug. 1969).

Polystyrene film doped with trans-stilbene has been found useful as a chemical dosimeter for ionizing radiation. It is insensitive to photon energy changes and dose rate over the photon energy range from 4.7 MeV to 1.25 keV (mean) and for rates from 300 rads/sec to 0.75×10^{14} rads/sec. The mechanism for the dosimetry reaction, isomerization of trans- to cis-stilbene, is analogous to the mechanism proposed for radiolytic isomerization for fluid solution in benzene and toluene. The useful range of these films is from 2×10^5 to 10^8 rads. (auth)

41080 THERMOLUMINESCENT GLASS DOSIMETER. Bekes, Martonne; Feher, Istvan; Deme, Sandor; Suha, Zoltan. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 179-84(1969). (In Hungarian).

The preparation techniques and main features of the glass dosimeter developed at the Institute are described. The composition of the glass dosimeter is similar to that reported in the literature. The optimum concentration of the Mn activator was found to be 0.06-0.08%. The dosimeter and the arrangement used for evaluation are linear in the range from 30 mR to 3000 R. The energy dependence of the glass can be considerably reduced by a 0.5 mm Cd-filter. The glass dosimeter is used primarily for emergency and local (e.g., finger) dosimetry. (auth)

Radiometric Instruments

41081 THE CONSTRUCTION OF CALIBRATION CURVES FOR DETERMINING WATER CONTENT FROM RADIATION COUNTS. Holland, D. A. (East Malling Research Station, Kent, Eng.). J. Soil Sci., 20: 132-40(Mar. 1969).

The principles involved in the calibration of a radiation counter are considered and their practical application are illustrated by the calibration of a β-ray gage for determining, in vivo, differences in the moisture content of leaves and the calibration of a neutron probe for the field determination of soil moisture content. Results showed that application of regression theory to the construction of calibration curves for the estimation of water content from an observed radiation count is possible only when the relation between count and water content is linear, a homogeneous error applies to the dependent variate, count, whatever its value, and the independent variate, water content, is determined free of error. Determination of the errors of estimation is further complicated by the necessity to fit the regression of count, as the dependent variate, on water content and then to invert the equation to estimate moisture content from count. It is shown that these requirements can be fulfilled by an initial transformation of the data and by repeated subsampling for the determination of water content. A method is given for calculating errors of estimation. Experimentally, it was found that a transformation (logarithmic) was necessary when calibrating a β-gage for moisture measurements. When calibrating a neutron probe for soil-moisture measurement, no transformation was required, but it was necessary to take repeated subsamples for water content determinations. (BBB)

41082 COMBINED SIDEWALL NEUTRON POROSITY GAMMA-GAMMA TOOL. Alger, Robert P.; Dewan, John T. (to Schlumberger Technology Corp.). U. S. Patent 3,453,433. Filed Dec. 8, 1966.

A specific embodiment of the invention provides a technique for measuring the porosity, matrix composition or gas saturation of an earth formation surrounding a borehole. The porosity may be measured by combining porosity-dependent signals derived from epithermal neutron radiation with porosity signals from a gamma-gamma density tool. The combined signals produce more accurate indications of formation porosity and also provide an indication of matrix lithology or gas saturation. (Official Gazette)

41083 CALIBRATION FOR THE GAMMA-RAY DENSITOMETER. 2. Muraki, Yoshio; Saito, Iwao (Hokkaido Development Bureau, Sapporo). Hokkaido Kaihatsu-Kyoku Doboku Shikenjo Geppo, No. 190, 1-4(Mar. 1969). (In Japanese).

A new method of calibration for the gamma-ray densitometer was developed, in which a single calibration curve is applicable for all kinds of material to be measured. With the calibration curve, the density is measured with some air space between the material and the probe, while in the conventional method the two are in contact. Results of additional tests are described. The test included 18 different samples. It was found that, with a single calibration curve, the wet density can be measured for materials, including peat, ice and snow, and concrete and asphalt, etc. With the air space distance of 0 to 8 cm, the sensitivity region in the vertical direction was about 13 cm, comparable with the conventional method. The most accurate calibration curve was found when the distance, by which the maximum count-rate ratio was shown, was taken as the space distance. With the definite distance of 4.5 cm, the difference in standard deviation from the above case was only 0.002 g/cm^3. (NSA of Japan)

41084 NUCLEAR INSTRUMENTATION DESIGN PROCEDURE FOR CONTINUOUS LEVEL AND INTERFACE MEASUREMENTS. Thomason, E. M. (Monsanto Co., Texas City, Texas). Anal. Instrum., 6: 243-60(1969).

From 14th Annual Analysis Instrumentation Symposium, Philadelphia, Pa. See CONF-680550.

A simple step-by-step design procedure that has converted the complexity of nuclear physics to nomographs and simple equations is presented. Several real problems are covered in the examples which provide additional guidance to the designer and points out some of the pitfalls that can occur, in the use of nuclear instrumentation. The instrument engineer can use this procedure to design nuclear measurement systems for continuous level and interface applications, thus increasing his ability to solve everyday measurement and control problems. (auth)

41085 SITUATION OF ISOTOPE APPLICATION IN THE HUNGARIAN PEOPLE'S REPUBLIC. Foeldiak, Gabor; Balla, Bela; Rozsa, Sandor (MTA Izotop Intezete, Budapest). Atomtech. Tajek., 11: 623-7(Dec. 1968). (In Hungarian).

About 300 nuclear industrial instruments are regularly used in Hungary, mainly in the mining industry, crude iron production, plate-mills, rubber industry, paper industry, leather-imitation production, power plants, ore processing enterprises, and the silicate industry. The most frequently used processes are the investigations of substance-flow for the determination of current velocity, average retention time, distribution, etc. Interesting are the investigations concerning the mixing of dusts, the determination of the efficiency of material separation processes, the control of leakage in chemical industrial equipments, and the determination of the quantity of different materials in closed equipments by dilution analysis. A cobalt irradiation source with an activity of 120,000 gRa equ. has been routinely used since the beginning of 1968; it is the biggest Hungarian gamma equipment. (auth)

41086 ECONOMIC EFFICIENCY OF ISOTOPIC THICKNESS GAGE AND REGULATOR SYSTEMS APPLIED IN COLD PLATE-MILLS. Abelovszky, Laszlo (MTA Izotop Intezete, Budapest). Atomtech. Tajek., 11: 628-30(Dec. 1968). (In Hungarian).

Owing to the application of the isotopic thickness gage the production increased from 18,016 tons to 19,918.3 tons in the cold plate-mill of the Csepel Iron and Metal Works. The realizable savings amount to 4.4 million Forints. (auth)

41087 ISOTOPIC INSTRUMENTS FOR SOLVING INDUSTRIAL TASKS IN THE HUNGARIAN PEOPLE'S REPUBLIC. Rozsa, Sandor (MTA Izotop Intezete, Budapest). Atomtech. Tajek., 11: 677-80(Dec. 1968). (In Hungarian).

In order to increase the safety of operation of industrial nuclear instruments work is going on at the Institute of Isotopes of the Hungarian Academy of Sciences for the construction of a multichannel instrument. The already elaborated gamma relay system contains parallel elements which ensure the operation of each channel separately. The component parts used in the parallel unit are highly reliable and their number is as small as possible (silicon transistors, MM condensers, metal layer resistors, etc.). A defectless control system was also developed. The Institute displays considerable activity in the field of the application of thickness gauges, too. The construction and operation experiences of the isotopic measuring and regulating equipment applied to leather imitation production are described. (auth)

41088 STATISTICAL EFFECTS IN RADIATION GAUGING. Adams, William L. (Industrial Nucleonics Corp., Columbus, Ohio). Anal. Instrum., 6: 229-41(1969).

From 14th Annual Analysis Instrumentation Symposium, Philadelphia, Pa. See CONF-680550.

Gaging systems using radioisotopes have many potential advantages. These advantages may be lost, however, if the systems are misapplied. The statistical nature of signals in nuclear systems has a strong effect on the application. The significance of the statistical nature of the radiation sources is analyzed in detail for interposed mass measuring and for level detecting systems. The relationships between source size, material thickness, and system accuracy are developed for thickness gages. The accuracy expression for continuous level detecting systems and the false alarm rate for level switch systems are derived. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 40817, 40940, 40951, 41038, 41314, 41613, 41699, 41731, 41923, and 43130.

41089 (BMwF-FBK-69-22) PROPERTIES OF A PROGRAM SYSTEM FOR COMPUTER CONTROLLED NUCLEAR PHYSICS EXPERIMENTS, DERIVED FROM ANALYSIS OF A SIMPLE EXPERIMENT. Frevert, L. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). June 1969. 65p. (In German). Dep.

A simple nuclear physics experiment which is to be performed with the assistance of a digital computer handling the data on-line, controlling the measurements, and automatizing parts of the experiment, is analyzed. The structure of the experiment program and some features of a system program are described, which connects the parts of the experiment program and permits multiprogramming. (auth)

41090 (BNWL-tr-37) CONTINUOUS MEASUREMENTS OF DEFORMATION DURING IN-REACTOR IRRADIATION. SOME RESULTS OBTAINED BY RESONANT CAVITY. Masson, M.; Millies, P.; Warlop, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report CEA-CONF-1117. 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 17816. (W.H.K.)

41091 (CEA-R-3709) TUNNEL DIODE AMPLIFIERS AND THEIR BACKGROUND NOISE AS A FUNCTION OF THE POLARIZATION POINT, THE TEMPERATURE, AND THE BANDWIDTH. Ozveaminian, Kazem (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). June 1969. 145p. (In French). Dep.

Thesis.

Mathematical and graphical methods for the study of the stability of tunnel diode circuits are presented, and applications to the realization of three amplifiers are given. A theoretical and experimental investigation of the noise of these amplifiers and of variations with the bias, the temperature, and the bandwidth is described. (auth)

41092 (CEA-R-3825) SPECIAL EQUIPMENT FOR PROCESSING CAN-RUPTURE MEASUREMENTS. Kaiser, Josef; Phalippou, Jacques; Dumont, Daniel; Viellard, Renaud (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1969. 67p. (In French). Dep. CFSTI (U. S. Sales Only).

Recent installations for detecting can-rupture in nuclear reactors use, in the measurement processing section, a digital computer, either completely or partially. The reliability of the system is limited by that of the computer, which represents a common point for the processing of data from the detector. In order to satisfy the demands imposed by safety considerations for the operation of the equipment it is necessary to consider the possibility of installing a second computer in certain cases. The use of a computer involves the presence of thresholds as interface between the detection equipment and the computer itself. In the case of a breakdown of the specialized equipment, the results from this prospector are no longer available but the others continue to operate. It seems that this solution is more reliable than that employing universal computers. By using an interchangeable drawer system (MULTIBLOC) it is possible to replace rapidly any of the specialized equipment which breaks down. The systematic use of integrated circuits (TTL) ensures an increased reliability of the equipment. (auth)

41093 (EUR-4289) ISPRA NUCLEAR ELECTRONICS SYMPOSIUM. Proceedings, Stresa, Italy, 6-9 May 1969. (European Atomic Energy Community, Brussels (Belgium). Center for Information and Documentation). 1969. 416p. (CONF-690515). DM 48; FB 600; FF 60; Lit. 7500; Fl. 43,50; $12.00.

Separate abstracts were prepared for fifty-eight of fifty-nine papers presented. The paper was previously included in NSA as 23: 33125. (B.G.D.)

For abstracts of individual papers see: 40985-40995, 41034-41044, and 41094-41129.

41094 (EUR-4289, pp 43-6) REALIZATION OF OPTIMUM PULSE SHAPING FILTER. Oda, Minoru (Mitsubishi Electric Corp., Amagasaki (Japan). Central Research Lab.).

A close approximation method of theoretically optimum filter is reported. The principle of this method is the subtraction of delayed single CR integrated pulse from multiple integrated pulse. Approximation accuracy is excellent and the calculated noise figure (NF) is 1.015. The effect of band width limitation of delaying elements is not a serious problem on the filter NF. Also reported is a method of eliminating the degradation of resolution due to the risetime spread of input signals. The risetime sensitivity is eliminated by this method with slight sacrifice of noise performance. (auth)

41095 (EUR-4289, pp 67-71) SIGNAL SHAPING, TRANSFORMATION AND GENERATION, USING BASIC ELEMENTS OF ANALOG AND DIGITAL COMPUTERS. Culjat, K.; Soucek, B.; Bonacic, V.; Matic, B. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)).

Some functional circuits are described for analog signal generation and transformation. Analog random noise generation and transformation and digital pseudorandom noise generation are discussed. (B.G.D.)

41096 (EUR-4289, pp 73-9) MAXIMUM LOOP GAIN OF FEEDBACK AMPLIFIERS WITH MONOTONIC STEP RESPONSE. Babic, H. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)).

A class of transfer functions for feedback amplifiers, which allow high loop gain is considered. With real poles only in the closed loop amplifier transfer function it follows that the optimum denominator of the open loop transfer function is a Chebishev's polynomial. Conditions for the realization of the pulse amplifiers with feedback pairs together with a high gain overall feedback are given. (auth)

41097 (EUR-4289, pp 81-4) AN OPERATIONAL PULSE AMPLIFIER WITH FET INPUT. Patzelt, R.; Posch, R. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronikinstitut).

The important characteristics of a linear pulse amplifier are defined. An operational pulse amplifier with FET-input has been designed. The differences and advantages compared to similar transistor circuits are discussed. The FET circuit is suitable for general applications because of its high input impedance, dynamic stability, linearity of open loop gain and overload characteristics. (auth)

41098 (EUR-4289, pp 107-10) DIGITAL, ANALOG, AND PROGRAM TECHNIQUES FOR ON-LINE COMPUTER CONTROL OF PHASED NEUTRON CHOPPERS. Russell, M. C. B.; Smith, D. B. J. (Atomic Energy Research Establishment, Harwell (England)).

A new system has been developed at Harwell for driving phased neutron choppers. It provides a general solution to the need for a power source with digital control, on-line from a computer, of the relative phase angle of any number of rotors whose parameters, for example speed, inertia, stiffness or electromechanical transfer characteristics, are not the same. Various ways are described for reaching synchronous speed and a simple way has been found for accelerating a 3-phase synchronous motor at zero slip frequency. (auth)

41099 (EUR-4289, pp 119-25) DIFFERENTIAL LINEARITY TESTING AND PRECISION CALIBRATION OF MULTICHANNEL TIME SORTERS. Bertolaccini, M.; Cova, S. (Politecnico di Milano (Italy). Istituto di Fisica).

The requirements for accurate differential linearity measurements of multichannel time sorters are discussed, and it is shown that these measurements can be practically done in reasonable counting time and employing standard laboratory instrumentation. Methods for absolute calibration are also considered, and a technique which is accurate and suitable for routine use is examined in detail. (auth)

41100 (EUR-4289, pp 127-35) WEIGHTED CHRONOTRON FOR TIME-DIGIT CONVERSION. Feran, Monica; Katz, Eli; Papina, Radu (Academia R. P. R., Bucharest. Institutul de Fizica Atomica).

A time interval is measured by counting the integer number of periods of a delay line generator with taps at weighted intervals, iteratively swept by a START pulse. The remainder of the time interval is measured by iteratively circulating START and STOP pulses through the weighted portions of the line and successively subtracting and registering them. (auth)

41101 (EUR-4289, pp 149-70) STATE OF ART IN MULTICHANNEL PULSE DATA ANALYSIS. Soucek, B. (Institut Rudjer Boskovic, Zagreb (Yugoslavia)).

In many nuclear physics, biology and engineering experiments it is important to measure the probability distribution function of random processes. A survey and comparison of different measuring techniques are given. The following systems and their basic principles of operations are described: single channel and multidiscriminator analyzers without memory, systems with fast digital memories and computer oriented systems, mean rate analyzer, multiparameter analyzers, analog memory analyzers with capacitors and with storage tubes, associative megachannel analyzers, most active zone encoder, pseudo-random transformation mode megachannel analyzer, window preselection, event recording, analyzers, spectrum stabilization, and trends in probability distribution measurements. (auth)

41102 (EUR-4289, pp 179-91) FAST ADC FOR PULSE HEIGHT ANALYSIS. Kurz, R. (Tennelec, Inc., Oak Ridge, Tenn.).

A unique 11-bit analog-to-digital converter based on a series-parallel technique is described. The short encoding time of 3 μsec (independent of channel number) makes multiplexing of several independent or dependent channels possible. Measured integral nonlinearity over all channels is less than 0.005% and differential linearity is in the order of 0.15%. Stretchers (peak or area), ADC, and multiplexer are designed as NIM modules. TTL integrated circuits are used for digital operations. Computer linking is convenient, or the ADC can be operated equally well with any memory unit. (auth)

41103 (EUR-4289, pp 193-203) ANALYSIS OF NONLINEAR FEEDBACK LOOPS IN PULSE STRETCHERS. Alleva, I.; De Lotto, I. (Centro Informazioni Studi Esperienze, Milan (Italy); Manfredi, P. F.; Maranesi, P. (Politecnico di Milano (Italy). Centro Studi Nucleari E. Fermi).

The behavior of a stretcher is analyzed, taking into account the effects of the main nonlinearities in the feedback loop. The dependence of the parameters of the active devices on their working point has been carefully examined. The COLDAC II computer program has been used for simulating the different circuit diagrams; the results are compared with the experimental outcome. (auth)

41104 (EUR-4289, pp 205-10) ANALOGUE-TO-DIGITAL CONVERTER EMPLOYING RECYCLED SUCCESSIVE APPROX-

IMATIONS. Kandiah, K.; Stirling, A.; Trotman, D. L. (Atomic Energy Research Establishment, Harwell (England)).

The successive approximation technique is faster than most other methods of analog-to-digital conversion. The main drawback is that it normally uses a multiplicity of high precision components. A method is described in which the signal is recycled through the same conversion stage by using sample and hold circuits. (auth)

41105 (EUR-4289, pp 225-9) DATA-HANDLING SYSTEM FOR LARGE-SCALE SPACE RADIATION EXPERIMENTS. Reagan, J. B.; Reed, R. D.; Bakke, J. C.; Matthews, J. D. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.).

A satellite data-handling system which controls, collects, identifies and transmits scientific data on Polar Cap Absorption (PCA) events and on auroral particle fluxes has been designed. The system controls the transmission and earth-reflected reception of signals from a multi-frequency ionospheric sounder on board the satellite. In addition, the system collects low and high energy particle radiation data in both digital and analog form from the twenty spectrometers and detectors which comprise the experimental payload. Appropriate identification data such as synchronization patterns and time information are provided in the resulting serial, pulse-code-modulated output to telemetry and ground-based digital computers. A description of the satellite data-handling system, the experimental payload and the telemetry system is presented. (auth)

41106 (EUR-4289, pp 231-5) COMPENSATION OF PULSE DETERIORATION IN MINIATURE CABLES BY MEANS OF SWITCHING TRANSISTORS. Maeder, D.; Vuilleumier, G. (Geneva Univ. (Switzerland). Laboratoire de Physique Nucleaire Experimentale).

Delay boxes for standard fast-logic pulses (2 ns FWHM) should have >400 MHz bandwidth. Amplitude loss and pulse widening data will be given for a 100 ns delay produced by different types of coaxial lines. In order to use a transistor for loss compensation, a special correction network adapted to the $\sqrt{f}$ attenuation characteristic is required. The theory of a suitable correction circuit is given, with numerical results for various RC combinations, up to 3 poles. Experimental tests show that the overall response function can be corrected within a fraction of a dB over a 300 MHz bandwidth. Application to variable-delay boxes is discussed. A slight circuit modification allows the use of the compensating transistor as the switching element for remote delay control. (auth)

41107 (EUR-4289, pp 243-6) DATA-COLLECTING SYSTEM FOR PULSE RADIOLYSIS EXPERIMENTS. Neisig, K. E.; Nielsen, S. O. (Danish Atomic Energy Commission, Risoe. Research Establishment).

The study of chemical reactions resulting from electron irradiation has been carried out by means of an advanced optical channel that measures the light transmission through a reaction cell containing the irradiated sample. The electronic instrumentation for these experiments and especially the digital equipment that collects all measurements and experimental parameters are described. (auth)

41108 (EUR-4289, pp 251-7) NUCLEONIC APPLICATIONS OF E^2CL MONOLITHIC INTEGRATED CIRCUITS. Cho, Z. H. (Stockholm Univ. (Sweden). Inst. of Physics).

Applications of a new generation of the E^2CL monolithic integrated circuits, whose propagation delay and rise time are only of the order of 1-2 ns, are described. The inherent high speed operation facilitates simple solutions for the construction of a nanosecond coincidence circuit and more complicated logic circuits. Advantages as well as some disadvantages of the E^2CL IC, in particular for the application to nuclear pulse circuitry, are discussed. Solutions for problems, especially in connection with the low output current and mismatching of the output impedance, are described. As application examples, a quadruple coincidence and mixer circuit, an E^2CL-TD binary, and a time to pulse-width conversion circuit are presented. For picosecond applications, e.g., the application to a TPHC etc., the time jitter of the E^2CL IC has also been investigated and the results are reported. (auth)

41109 (EUR-4289, pp 265-7) DIGITAL HIGH-VOLTAGE SUPPLY FOR AUTOMATIC TESTING AND REGULATION OF PHOTOMULTIPLIER GAIN. Maeder, D. (Geneva Univ. (Switzerland). Laboratoire de Physique Nucleaire Experimentale).

The main constituents of an automatic testing and regulating system are recalled. Automatic control is required for logic modules, delay boxes, attenuators, and phototube voltage supplies. Rather than depending on automatic monitoring of manually adjusted voltages, a direct digital setting of nominal voltages should be attempted. The original prototype, adjustable from 0 to 2555 V in 5 V steps, was built as a self-contained module, with complete manual and electronic control circuits. A more recent version, oriented towards CAMAC control of a large number of identical channels, requires a separate control panel for manual operation; on the other hand, its compactness allows 16 channels to be housed in one crate. Circuit diagrams and performance data are presented. (auth)

41110 (EUR-4289, pp 277-81) COMPUTER SYSTEM FOR ON-LINE NEUTRONIC NOISE ANALYSIS AND CALCULATION OF NUCLEAR REACTOR PARAMETERS. Carapic, M.; Velasevic, D.; Stankovic, S. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)).

The system design is based on the theoretical and experimental work known as variance to the mean method. The variance to the mean method in on-line computer application is described. The interface hardware and basic ideas of programming and conceptual advantages over the existing systems are discussed. (auth)

41111 (EUR-4289, pp 283-9) COMPUTER ON LINE IN ACTIVATION MEASUREMENTS. Arcipiani, L.; Farinelli, U.; Gibello, A. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari).

The problems involved in large scale automation of experimental laboratories are briefly discussed. The possibility of automating experiments of different types by means of a central computer working in time-sharing is being investigated at Casaccia. To gain experience in this respect, the equipment for activation measurements of the Reactor Physics Laboratory has been connected to an IBM 360/30 computer. The time sequence of the experiments is controlled by the computer, and the processing of data is carried out in real time. Hardware, software and operating procedures are briefly reviewed. The need to keep a high degree of flexibility is stressed. (auth)

41112 (EUR-4289, pp 291-2) USE OF A COMPUTER ON-LINE IN EXPERIMENTS AT THE FAST CRITICAL ASSEMBLY SNEAK. van Velze, P. L.; Walze, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik).

A DDP-124 computer with a data acquisition system is used for on-line data processing and control of nuclear reactor experiments at the fast critical assembly SNEAK. Some of the applications are described. It is shown that by using an on-line computer experiments at the reactor can be performed with a considerably improved efficiency. (auth)

41113 (EUR-4289, pp 293-7) NUDIAC: DATA ACQUISITION AND PROCESSING SYSTEM APPLIED TO PHYSICS EXPERIMENTS AND TO NUCLEAR MEASUREMENTS. Moisset, J.; Barthelemy, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The system presented here was designed to perform the functions involved in the acquisition, processing, display and filing of experimental data, particularly in the field of nuclear spectrometry. It is set up around a central computer unit with 8,000 words of 18 bits and having as special peripheral equipment a display unit and a disc memory. A direct-access multi-channel acquisition coupler gives simultaneous handling facilities for several acquisition channels in different modes (e.g. amplitude analysis, multiscale mode and multi-sampling). The obtained data are processed by external patch programs with a high processing speed which utilise the microprogramming possibilities of the central unit. The system is programmed by a simplified original and interpretative-type language (PHITROL) geared to spectrum processing. (auth)

41114 (EUR-4289, pp 299-304) AN ON-LINE DATA HANDLING SYSTEM FOR PHYSICS EXPERIMENTS AT THE SWISS FEDERAL INSTITUTE FOR REACTOR RESEARCH. Bossel, J.-B.; Haelg, W. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)).

An on-line data registration and reduction system with a computer CDC 8090 serves primarily neutron scattering experiments. The instruments connected to the computer system for this purpose are a time-of-flight spectrometer and a multiaxis spectrometer. Beside this, the system also registers data for the study of heat transfer in a Natrium Loop, and processes 247 temperatures of the Reactor Diorit. All connections between the computer and its peripherals use telephone cable, each line consisting of a twisted pair of conductors terminated on 75 Ohms, the longest connection being for the time 300 m long. An appreciation on the reliability of this system is also presented. (auth)

41115 (EUR-4289, pp 305-6) CAMAC MULTI-USER SYSTEM. Best, G. C.; Hooton, I. N. (Atomic Energy Research Establishment, Harwell (England)).

A data collection system for multi-user access to a small computer is being implemented using CAMAC hardware. The system is described, and some of the general principles involved in the software for such systems are discussed. (auth)

41116 (EUR-4289, pp 307-12) ON THE "ESTER" SYSTEM FOR SIMULTANEOUS RUNNING OF SEVERAL ON-LINE MULTIPARAMETRIC EXPERIMENTS. Zen, J.; Muser, A.; Michaud, J. D.; Scheibling, F. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires).

An on-line data acquisition and processing system using an IBM 1800 computer is described. This system allows several independent research teams to use simultaneously the computer for real time data acquisition and processing on a multilevel priority time sharing basis. (auth)

41117 (EUR-4289, pp 313-16) DATA ACQUISITION AND REDUCTION IN ACTIVATION ANALYSIS BY ON LINE COMPUTER. Di Cola, G.; Girardi, F.; Guzzi, G.; Termanini, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The direct connection between an activation analysis laboratory and an IBM 360/65 computer is presented. The system is designed to automatically process data from gamma spectrometers in a minimal time. Control analyses needing a fast answer can thus be performed with an increased overall productivity of the equipment. (auth)

41118 (EUR-4289, pp 317-19) DATA HANDLING SYSTEM FOR ACTIVATION ANALYSIS BY MEANS OF A SMALL PROCESS COMPUTER. Christensen, Palle; Christiansen, E. Mose (Danish Atomic Energy Commission, Risoe. Research Establishment).

A central data handling system for three pulse-height analysers already in use in activation analysis is described. PHA data are transferred to an incremental magnetic tape recorder via a PDP 8 I with a 32 k disk. An oscilloscope is used for spectrum display and as an aid in peak calculations. System commands are given from a teletype. (auth)

41119 (EUR-4289, pp 321-30) DISPLAY TERMINAL FOR ON-LINE NUCLEAR EXPERIMENTS. Klessmann, H.; Zahn, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)).

Design considerations and characteristics of an experimental display terminal are presented which was designed particularly for on-line nuclear experiments. Data are displayed on a direct-view storage tube which eliminates the need for refreshing the information display and allows to have only a small display file in the computer memory if information is plotted as it is generated by the computer program. Thus both computing time and computer storage capacity can be used more economically. A general command and data structure has been chosen for handling several different modes of display operation. By strictly modular design a very simple display having random point plot capability only can be extended to a more elaborate system with incremental or sequential point plot or with vector and character generation. In the simplest point plot mode any point may be addressed at random by one 24 bit word with 2 × 1024 dot array. It takes 120 μs/dot for positioning and writing which corresponds to a maximum plotting rate of 8000 dots/s. For short deflections only the 5 least significant bits may be used which provides two points per 24 bit word and reduces plot time to 30 μs/dot. Nuclear data like single and multiparameter spectra can be displayed in isometric and map representation with any format in x and y up to 128 × 128 channels (corresponding to about 16,000 dots displayed within 2 seconds). The information stored on the screen can be changed only by total erasure (0.5 seconds) and display of a new modified picture. This prevents real live display of an accumulating spectrum. Instead snap-shots of a growing spectrum are displayed at equal intervals which can be selected (e.g. 10 seconds). This method suggests that not the counts accumulated in each channel are displayed but the mean rate in counts per time interval by averaging at the end of each interval over all completed ones. This eliminates the need for changing the z-range of the display continuously because the accumulating spectrum will stay on the screen while improving its shape during the course of the experiment. Furthermore, only 10 bit data representing the calculated mean count rate is transferred to the display which eliminates the normal 20 bit data transfer from which 10 bits are selected at the terminal according to the required z-range. All display functions like mode switching, format, range logarithmic presentation, etc., are controlled by means of function keys and command words via the computer. A cursor in write-through mode may be used instead of a light pen as a graphical input device to identify and mark particular points or areas of interest. (auth)

41120 (EUR-4289, pp 331) COMPUTER CONTROLLED DATAWAY FOR NUCLEAR INFORMATIONS. Gilbert, J. F.; Girod, J. J.; Lecomte, J. L.; Lesourne, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

A communication network developed at the Nuclear Research Center of Grenoble for connecting a number of experiments with an IBM 360/40 computer is described. The communication network is managed by a CII 90-10 computer (memory 8k × 12 bits). (B.G.D.)

41121 (EUR-4289, pp 339-45) IMPROVEMENT OF SLIDING-SCALE ANALOG-TO-DIGITAL CONVERTERS THROUGH WEIGHTED AVERAGING. Gatti, E. (Centro Informazioni Studi Esperienze, Milan (Italy). Politecnico di Milano (Italy)); Manfredi, P. F. (Politecnico di Milano (Italy). Centro Studi Nucleari E. Fermi); Svelto, V. (Centro Informazioni Studi Esperienze, Milan (Italy). Aquila Univ. (Italy)); Thieberger, P. (Stockholm Univ. (Sweden). Research Inst. for Physics. Tennelec Instrument Co., Oak Ridge, Tenn.).

Several figures of merit for characterizing an analog-to-digital converter are considered. It is shown that the sliding scale method of improving through averaging the performance of a converter can be made more effective by introducing variable statistical weights in the averaging procedure. It is found that a parabolic weighting function is the optimum for the differential linearity, if the channel boundaries are independently random distributed with equal variance. Moreover it is shown, through a computer simulation, that this weighting function is more convenient than a rectangular one to improve also a local differential linearity, while it is equivalent as far as correction of channel centroid errors is concerned. A triangular weighing function is found to be slightly worse than the parabolic one as far as overall differential linearity is concerned but somewhat better from the point of view of local behavior. (auth)

41122 (EUR-4289, pp 347-8) OPTIMUM STATISTICAL EQUALIZATION IN CONTROLLED ANALOG TO DIGITAL CONVERTERS. Abbattista, N.; Marangelli, B.; Marino, D.; Plantamura, V. L. (Bari Univ. (Italy). Istituto di Fisica).

The operation of an analog-to-digital converter with statistical equalization was examined. A theoretical analysis was carried out by simulation on a digital computer and an experimental analysis by means of a particular successive binary approximation. (B.G.D.)

41123 (EUR-4289, pp 355-62) THE MEASUREMENT OF AUTOCORRELATION AND CROSSCORRELATION FUNCTIONS IN THE FAST DOMAIN AND ITS APPLICATIONS TO NUCLEAR ELECTRONICS. Amsel, G.; Bosshard, R.; Rausch, R.; Sauce, M.; Zajde, C. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire).

Auto and crosscorrelation functions of binary or gaussian processes were measured with subnanosecond precision using sampling and averaging techniques, yielding high speed automatic operation. For gaussian processes two methods are described based on conditional probabilities and sign correlation. Applications are shown to the characterization of noise from pulse amplifiers and photomultipliers and of the dead time properties of fast randomly operated switching circuits. (auth)

41124 (EUR-4289, pp 363-70) NEW GENERAL PURPOSE CORRELATION FUNCTION COMPUTER. Quayle, Ian H. (AIM Electronics Ltd., Cambridge (England)).

A brief introduction to correlation technique is given, followed by a description of a hybrid correlation function computer. (auth)

41125 (EUR-4289, pp 371-3) SWITCHING CIRCUITS OPTIMAL CONFIGURATION FOR AMPLITUDE DISCRIMINATION AND TIMING. Abbattista, N.; Plantamura, V. L.; Giannelli, G. (Bari Univ. (Italy). Istituto di Fisica); Coli, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati).

The switching circuits in their typical applications as amplitude discriminators and timing shapers were studied describing the output random process as a function of the input signal parameter random distributions. It is shown that the effect of the fluctuations of some input signal parameters randomly distributed may be reported to the input as a noise contribution to be added to the input signal noise. A deterministic model is proposed to allow the input to the output transformation. Finally, some circuit configurations suited to perform the optimal information treatment for amplitude discrimination and timing are discussed. (auth)

41126 (EUR-4289, pp 379-83) THE CAMAC SYSTEM OF MODULAR INSTRUMENTATION. Barnes, R. C. M.; Hooton, I. N. (Atomic Energy Research Establishment, Harwell (England)).

A new standard for modular instrumentation has been developed by the ESONE (European Standard of Nuclear Electronics) Committee and adopted by many European nuclear laboratories. The outstanding characteristic of this standard is a highway for the transfer of digital data and control information. This and other main features of the CAMAC specification are introduced in this paper. The use of CAMAC is illustrated by outlining the organization of a typical small system in which CAMAC units are associated with a PDP-8 computer to operate as a multichannel analyzer. (auth)

41127 (EUR-4289, pp 385-9) PROJECT AGORA: ADAPTATIVE NETWORK FOR DATA COLLECTION AND TRANSMISSION. Mougel, J. F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The aim of AGORA is to ensure all information transfers among three computers of different type (C.I.I. 10020 and PDP 8). These transfers are automatically performed between the memories of computers and are controlled by the central unit of one of them. A high performance display is associated to the transmission network. A synthetic language is being written. (auth)

41128 (EUR-4289, pp 391-4) CAMAC CRATE CONTROL FOR A PDP8 AND A CAMAC 24 BIT COUNTER. Attwenger, W.; Egl, W.; May, F.; Patzelt, R.; Petreczek, K.; Schwarzer, J. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Elektronikinstitut).

A CAMAC crate control for a PDP 8 or a semiautomatic control system and a 24 bit preset counter for the CAMAC system is described. Details of the use of four device addresses of the PDP 8 and timing requirements are described. For the preset counter two methods are compared. (auth)

41129 (EUR-4289, pp 395-7) PROGRAMMED CONTROL OF AUTONOMOUS TRANSFERS IN A CAMAC SYSTEM. Richards, J. M.; Ward, L. D. (Atomic Energy Research Establishment, Harwell (England)).

The transfer of data under the control of a CAMAC installation is essential in many applications. The programmed control of these transfers can provide very desirable flexibility. This is illustrated by the Programmed Command Generator 7038 which is an autonomous transfer controller in the Harwell 7000 Series of CAMAC units. (auth)

41130 (IDO-12071, pp 14-17) INSTRUMENTATION BRANCH. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

Routine and special instrumentation activities are outlined, and research and development projects are briefly described including an aerial monitoring system, in vivo plutonium-239 detection, horizontal rotational scanner, X-Y scanning attachment, and an automatic changer for radon scintillation cells. (W.H.K.)

41131 (IDO-17299) INSTRUMENT DEVELOPMENT BRANCH ANNUAL REPORT, 1968. Morrison, R. G. (ed.); Colson, J. B.; Gossmann, S. R.; Wilde, N. (comps.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). July 1969. Contract AT(10-1)-205. 105p. Dep. CFSTI.

ACOUSTIC EMISSION TESTING — instrumentation for, development of
AMPLIFIERS — development of low-level dc, for use with thermocouples
ANEMOMETERS — development of ultrasonic, for measurement of steam convection currents in LOFT reactor
BOILERS — operating saturation conditions in, simulation of
CATTLE — iodine-131 distribution in, computer simulation of
CIRCUITS — design of exponential voltage generator for simulating reactor periods
DATA PROCESSING SYSTEMS — development of 100-channel analog data multiplexer
— description of LOFT
EDDY CURRENT TESTING — development for measurement of transient diametrical growth and temperature of fuel rods
— development for detection of departure from nucleate boiling
— circuit for
LEVEL INDICATORS — development of capacitance, for dielectric materials
MATERIALS TESTING REACTOR — fuel element-to-reflector channel spacing measurement
REACTOR CONTAINMENT STRUCTURES — flaw transducers for
REACTOR FUEL ELEMENTS — temperature during flooding of, development of instrumentation for measurement of
REACTORS, POWER — fuel element cladding for, effects of steam emergency core cooldown operation on response of Zircaloy
REACTORS, RESEARCH — startup tests of FRAN, results and analysis of
— core of FRAN, relative power density map and flux profiles of
SEALS AND GLANDS — development of high-temperature high-pressure nonwettable feedthrough
STRAIN GAGES — development for use in pressurized steam atmospheres
TEMPERATURE CONTROL — circuits for thermoelectric devices
THERMOCOUPLES — performance and compatibility with Zircaloy at high temperatures
TRANSDUCERS — development of feedback-compensated linear variable differential transformer for displacement measurements in LOFT reactor
— development of linear variable differential transformer for measurement of reactor fuel growth
ZIRCALOY — surface friction coefficients with nickel and Inconel (W.H.K.)

41132 (INR-953) SOME EXAMPLES OF USING "GIER" COMPUTER FOR EXPERIMENTAL DATA PROCESSING. Dakowski, M.; Gadomski, A.; Piasecki, E. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 133p. (In Polish). Dep.

Nine computer programs designed for processing data obtained using a multichannel one- or two-dimensional analyzer are described. They can be used for: (a) fitting by means of the least squares method the polynomial of the order up to 4 or the Gaussian distribution to the experimental data, (b) performing simple arithmetic operations on the data, (c) providing for the instability and/or nonlinearity, (d) providing for the energy spectrum distortion due to passing of charged particle through an absorber, (e) plotting histograms in linear and/or logarithmic scale, (f) projecting two-parametric experiment data onto the coordinate axis, and (g) calculating the energy spectra of the particular particles from the data obtained in the telescope experiment. The programs are written in the GIER ALGOL III code, but knowledge of programming is not necessary for using them. (auth)

41133 (INR-1052) A 10 MHz DECIMAL COUNTER WITH LOGIC GATES. Bayer, R.; Koba, T.; Kulka, Z.; Nadachowski, M. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 18p. (In Polish). Dep.

The design and performance of a 10 MHz decimal counter with a 1-2-4-8 code are described. The counter consists of four bistables and logic gates "AND." The circuit has been used in the decimal registers of analog-to-digital converter. (auth)

41134 (K-1776) VACUUM-LOCK ACTUATOR AND ION-SOURCE POSITIONER FOR A SURFACE IONIZATION MASS SPECTROMETER. Howard, Olin H.; Langdon, Aubrey; Taylor, Fred W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Aug. 4, 1969. Contract W-7405-eng-26. 10p. Dep. CFSTI.

A vacuum-lock actuator and an ion-source positioner were designed, fabricated, and installed on a surface ionization mass spectrometer to eliminate stressing of the analyzer tube, which impairs its alignment. The electrically powered vacuum-lock actuator also eliminates the manual effort formerly required to operate the vacuum lock. (auth)

41135 (ORNL-TM-2665) A SUPERCONDUCTING (Nb-Ti) LIQUID HELIUM LEVEL DETECTOR. Efferson, K. R. (Oak Ridge National Lab., Tenn.). July 1969. 18p. (CONF-690623-1). Dep. CFSTI.

From Cryogenic Engineering Conference, Los Angeles, Calif.

A superconducting liquid helium level indicator has been constructed and tested which utilizes a small Nb-Ti wire as the detector element. A heater creates and helps maintain a normal zone in that portion of the wire which is above the liquid helium level while that portion of the wire below the liquid level remains superconducting. Thus, the liquid helium level is determined by the position of the normal-superconducting boundary. The output voltage is very high (0.22 volts/cm at 50 mA) and varies linearly with a change in position of the liquid level. This device works in much the same way as previous detectors made with Ta or a Pb-Sn alloy, however, it has the added advantage that it can be used in high magnetic fields. Data and construction details are presented. (auth)

41136 (UCRL-18883) SYSTEM OPERATION OF THE PDP-7 COMPUTERS AT LRL, BERKELEY. Radeloff, J. O.; Robinson, L. B.; Meng, J. D. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1969. Contract W-7405-eng-48. 104p. Dep. CFSTI.

An on-line data-taking system based on a PDP-7 computer has been developed. The system allows a time-shared use of the computer with several counting experiments. The data areas are hardware protected against interference between different users. DEC-tapes are used for storage and retrieval of the programs. Data are stored either on DEC-tape or IBM-compatible magnetic tape. The operation of the data taking system is described. A software handling program package operating with DEC-tape is also introduced. (auth)

41137 (UCRL-19030) USE OF SUPERCONDUCTING JUNCTIONS IN MAGNETOMETRY. Clarke, J. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 13p. (CONF-690529-1). Dep. CFSTI.

From National Center of Space Studies Meeting, Paris, France.

A superconducting device which has proved useful in the measurement of electric currents down to 30 nA, voltages down to 10^{-15} V, and magnetic fields down to 10^{-8} Gauss is described. The properties of a type of Josephson junction in which the conventional oxide barrier is replaced by a copper barrier are discussed. (auth)

41138 (UCRL-50654) ON THE RELATIONSHIP OF EXCESS PHASE DISPERSION TO THE ANOMALIES OF BROADBAND SYSTEM COMPENSATION. Ekstrom, M. P. (California Univ., Livermore. Lawrence Radiation Lab.). June 20, 1969. 17p. Dep. CFSTI.

One of the factors most strongly affecting the compensation of transmission systems is excess phase dispersion. The limitations this dispersion imposes on the system correction are considered from the view of one interested in baseband, pulse fidelity. Frequency domain expressions for system amplitude and phase distortion are presented. Through use of Hilbert transforms, the distortion is so classified as to clearly delineate the circumstances under which it can be corrected. The broadband compensation of TEM coaxial cable is given to illustrate the actual design restrictions encountered in practice. (auth)

41139 (UUIP-630) EVALUATION OF CAPACITANCE MEASUREMENTS ON HIGH-RESISTIVITY SILICON SURFACE BARRIER DIODES. Berg, S.; Andersson, L. P.; Garcia Pacheco, O. M.; Boonthanom, N. (Uppsala Univ. (Sweden). Inst. of Physics). Feb. 1969. 32p. Dep.

The relationship between capacitance and voltage was measured on surface-barrier diodes manufactured from high resistivity n-type silicon. The samples had resistivities 100-25,000 Ω/cm and measurements were made using frequencies from 5 kHz to 500 kHz. The manufactured diodes were of the same dimensions as those commonly used as particle-detectors for nuclear radiation. Front contacts were made by evaporation of gold at an ultimate pressure of 10^{-5} mm Hg. Before evaporation silicon crystals were polished and chemically etched by a standard CP6-solution. In addition to capacitance, forward and backward currents were studied. Three simple models for the width of the depletion region are presented. It is shown that none of these theories alone can explain the measured results. Due to the large discrepancies between the theoretical junction widths and the measured values, a more realistic model of the depletion region is necessary. An expression was derived which was found to be in very good agreement with experimental results. The origin of the barrier-height between gold and silicon is discussed. The frequency dependence of capacitance values for Schottky diodes manufactured on high resistivity silicon is shown to be expected because of the finite time constant of the undepleted region of the bulk material for the diodes investigated in this work. A simple model is presented. (auth)

41140 COMPUTER INPUT OF THE INFORMATION FROM A MULTICHANNEL IONIZATION CALORIMETER. Ogurtsov, O. F. Kosm. Luchi, No. 10, 65-8(1969). (In Russian).

A magnetic memory with short-circuited-turn type of control has been developed for automatic processing of data from an ionization calorimeter. The device serves for computer input of necessary data. (auth)

41141 PROCESSING OF THE DATA OF COSMIC-RAY STATIONS. Pimenov, I. A. Kosm. Luchi, No. 10, 17-19 (1969). (In Russian).

A new instrument to be used in studying cosmic ray variations—a cosmic-ray station (CRS) is briefly examined, considering the station as a source of information. One of the possible versions of central data processing system is proposed, the system consisting of 10 CRSs and a computer of high information capacity. The system when realised will accomplish: (1) automatic recording of data output from CRS, (2) current analysis of the data obtained and a thorough analysis of the accumulated data, (3) automatic printout of the results of recording and processing, (4) computing on programs independent of the directly received data. (auth)

41142 500-CHANNEL SPECTROMETER FOR AN IONIZATION CALORIMETER AND RESULTS ACHIEVED FROM ITS LONG SERVICE. Ogurtsov, O. F. Kosm. Luchi, No. 10, 69-74 (1969). (In Russian).

The general operational scheme of an ionization calorimeter used for the study of particle interaction at energies of $10^{11}-10^{12}$ eV is considered. The device permits to obtain information in the form of a clear picture of the volume ionization in the calorimeter. Reliability and accuracy estimates based on the one year of operation results are presented. (auth)

41143 DESIGNING MOS SYSTEMS FOR RADIATION ENVIRONMENTS. Holmes-Siedle, A. G.; Zaininger, K. H. (RCA Labs., Princeton, N. J.). Solid State Technol., 12: 40-9, 71(May 1969).

Effects which are noted when an MIS (Metal-Insulator-Semiconductor) device such as the MOS (Metal-Oxide-Semiconductor) transistor is exposed to nuclear radiation are reviewed. The principal effect is not strictly a degradation, as is the case in solar cells or bipolar transistors; instead the MIS transistor undergoes a change of operating region, i.e., a shift in the bias-dependent characteristics of the device. Other less regularly observed changes are variations in the shape of the characteristic curve and increased leakage current. Both of these are effectively degradations. The physics of these effects in MIS devices is discussed, as well as the recently discovered radiation-hardness of aluminum oxide as a gate insulator. The known radiation data are surveyed and methods of reducing the impact of radiation on the devices are proposed. It should be possible to greatly improve the radiation-hardness of MOS devices by finding process techniques which reduce holetrap concentration in the oxide or in other insulators substituted for the present silicon dioxide layers. The processes concerned are well enough understood and sufficiently predictable so that methods of disigning circuits and systems to accommodate the radiation effect can now be devised. (BBB)

41144 PROCEEDINGS OF THE THIRD INTERNATIONAL MEETING ON ELECTRONICS AND AUTOMATION, HERCEG NOVI, YUGOSLAVIA, 24-29 JUNE 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Institute of Nuclear Sciences, 1968. 446p. (In French and English). (CONF-680642).

Separate abstracts were prepared for 14 of the 25 papers presented. The remaining 11 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 41014-41016, 41049-41051, 41065, 41147-41150, 43101, 43152, and 43153.

41145 MASS SPECTROMETER ION SOURCE WITH A TWO REGION IONIZATION CHAMBER TO MINIMIZE ENERGY SPREADING OF THE IONS. Werner, Helmut Wilhelm. (to Philips Corp.). U. S. Patent 3,461,285. Priority date July 2, 1966, Netherlands.

An ion source for a mass spectrometer in which ions are formed by ionization of a gas with an electron beam collimated by a magnetic field in the direction of the beam is described. The ions formed are extracted from the ionization space through a small gap parallel to the direction of the electron beam by means of an electric field which extends at right angles to the direction of the electron beam. A flat grid-like electrode is provided consisting of parallel wires which cross the direction of the electron beam, the latter electrode dividing the ionization space into two zones one of which contains the ionization gap. A potential is applied to the grid-like electrode which in combination with potentials applied to the other electrode produces a small voltage gradient in the first zone and a large voltage gradient in the other zone. (Offic. Gaz.)

41146 "HOT" LUMINESCENCE LINES IN THE SECONDARY RADIATION SPECTRA OF $KCl-NO_2^-$ AND $KBr-NO_2^-$ CRYSTALS. SUMMARY. Saari, P.; Rebane, K. (Inst. of Cybernetics, Tallinn). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 18: 255-6(1969). (In Russian).

An attempt was made to reduce the drift and differential noise of external stabilizers of nuclear magnetic double resonance spectrometers operating with separate specimens. A hollow probe with the specimen placed inside and a separated high-frequency field was designed for stabilizing and recording the spectrum. The relative stabilizer instability with the designed probe was 2×10^{-11} per sec and 1×10^{-9} per 10 min. (R.V.J.)

41147 COMPUTER SYSTEM FOR ON-LINE NEUTRONIC NOISE ANALYSIS AND CALCULATION OF NUCLEAR PARAMETERS. Carapic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 349-61 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24-29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968.

See CONF-680642.

The system design is based on the theoretical and experimental work known as variance to the mean method. The variance to the mean method in on-line computer application is described. The interface and basic ideas of programing and conceptual advantage over the existing systems are discussed. (auth)

41148 SOME EXAMPLES OF THE USE OF REAL-TIME COMPUTERS FOR THE CADARACHE CORE. Viers, M.; Friedling, G. (CEN, Cadarache, France). pp 229-49 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24-29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).

See CONF-680642.

The discussion covers processing in real time for results of oscillations in the Cesar reactor, data acquisition for safety testing on a graphite ring, and automatization of the Cadarache Van de Graaff. (J.F.P.)

41149 USE OF COMPUTERS IN NUCLEAR PHYSICS. Mougel, J. F. (CEN, Saclay, France). pp 201-28 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24-29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968. (In French).

See CONF-680642.

A comparison of systems is made. Means of liaison with the experimental arrangement are described. Programing for the computer and the application of various types of computers to experimental requirements are discussed. (J.F.P.)

41150 THE DESIGN PRINCIPLES OF AN ADVANCED MODULAR SYSTEM OF NUCLEAR ELECTRONICS FOR ON LINE COMPUTER APPLICATIONS. Bisby, H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 113-34 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24-29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968.

See CONF-680642.

The present state of IANUS, an advanced modular system of nuclear electronics for the real-time association of transducers with computers and other data processing devices, is described. The operational role and the design principles of IANUS are given. The physical form, power distribution, data transfer, and signal levels are discussed. (J.F.P.)

41151 FLEXIBLE CHANNEL MULTIPLIER. Hayashi, Tomonas; Hashimoto, Masashi (Tokyo Univ.). Shitsuryo Bunseki, 17: 639-41(June 1969). (In Japanese).

A study on a flexible channel multiplier made of electron conductive polymer is reported. The tube is molded by extruding the material through a die under proper temperature and pressure. The secondary electron emission ratio δ of the material used is about 2.5 at 200 eV in primary electron energy. The multiplier was operated in counting mode for investigating the gain and the deterioration. From the study on the gain distribution by means of a pulse height analyzer the most appropriate value of the accelerating voltage has been found to be 3000 V. At this voltage the gain up to 2.5×10^8 can be expected. It has been proved that this multiplier is also applicable to a photon counter in vacuum ultraviolet region. (auth) (NSA of Japan)

41152 A COMPACT REGULATED E.H.T. SOURCE FOR PHOTOMULTIPLIERS. Box, G. F. (Commonwealth Scientific and Industrial Research Organization, Melbourne). Aust. J. Instrum. Contr., 25: 14-16(June 1969).

A circuit is described of a dc/dc converter followed by a neon logic diode regulator for extra-high tension power (E.H.T.) supply for a photomultiplier or electron beam multiplier in transistorized equipment. The diode regulator has a 500/1 stabilization ratio. By using a dc source with a stability against mains variation of 0.1% to power the converter, the resultant overall short term stability approaches 0.0002%. Input power is 15 volts at 200 milliamps. Output is approximately −1420 volts at the converter output terminals. In operation the E.H.T. output voltage can be varied from −820 down to −330 volts in steps of 55 volts. Suggestions are made for increasing the voltage output of the source. (Australia)

41153 NEUTRON CHOPPER. Watanabe, Mitsuhito (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho, 43: 996-1001(July 1969). (In Japanese).

A neutron chopper is a fundamental component in neutron experiments using a time-of-flight method. The mechanical performance of a newly developed neutron chopper is described. A rotor in this device is made of K monel weighing about 16 kg and provided with ten slits each having an effective length of 250 mm (0.5 mm wide by 25 mm high). In constructing the rotor, a special shape is given to it by cutting off a low stressed part of the conventional circular rotor and limit design is made to allow plastic deformation locally so that it can withstand a high rotational speed of 30,000 rpm. On the other hand single unit tests are conducted on grease lubricated ball bearings and vacuum seals which are components of a high speed drive unit to confirm high speed performance. As a result of operation of the neutron chopper, it is proved that the vibrational amplitude of the rotor is below 30 μ, the degree of vacuum is $(8 \sim 10) \times 10^{-2}$ torr and the temperature rise is below 35°C at each part, thus unattended operation being practicable. (auth) (NSA of Japan)

41154 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 26. Marton, L. (ed.). New York, Academic Press, Inc., 1969. 448p. $19.50.

Separate abstracts were prepared for two of the five review papers presented. The remaining three papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 41019 and 42808.

41155 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 25. Marton, L. (ed.). New York, Academic Press, Inc., 1968. 354p. $16.00.

A separate abstract was prepared for one of the five review papers presented. The remaining four papers were not within the scope of NSA. (W.H.K.)

For an abstract of the individual paper see: 42807.

41156 LOW FREQUENCY RANDOM SIGNAL GENERATOR WITH RADIOACTIVE SOURCE. Ueno, Toshiyuki (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 5: 211-21 (Apr. 1969). (In Japanese).

A simple noise generator using a radioactive source as the primary noise source is described and a brief survey of generating low frequency random signals is given. A flip-flop symmetrically triggered by a Geiger–Mueller counter actuated with a radioactive source yields a random telegraph signal with Poisson-distributed zero crossings. The random telegraph signal has a frequency spectrum extending from, say, 10 Hz to zero frequency. The output power spectrum may be altered to meet a given requirement by linear shaping filters. The device provides random signals for statistical investigation of control systems and for studies of correlation and power spectral analysis. (auth) (NSA of Japan)

41157 APPLICATION OF NEUTRON THERMOPILE TO MAJOR INSTRUMENTATION OF NUCLEAR REACTOR. Kataoka, Haruo. Oyo Butsuri, 38: 634-44(July 1969). (In Japanese).

The neutron thermopile is an excellent neutron flux detector and has many better points than the chamber type has. However, the fact that its action is accompanied by time lag is fatal to it. Furthermore, because of its various defects, that is, disturbance signal induced by ambient temperature change and damage of junctions resulting from neutron irradiation, it has not been used in the past for the purpose of direct control and major safety of the reactor. It was used only for safety back up and monitoring in the reactor. In this point of view, the application of the neutron thermopile for control and safety of the nuclear reactor was studied. The study included investigation of (a) the method for compensating time lag resulting from its responsive action by using the time constant compensating circuit, (b) the method for preventing the induction of the disturbance signal caused by a change in ambient temperature, and (c) the method for calibrating changes in the characteristics of the junctions by making use of Peltier's effect. As the results, these methods have been enabled to serve the practical purpose. Thus, it can be thought that the neutron thermopile should be used as the major instrumentation designed for the direct control and major safety of the reactor. (auth) (NSA of Japan)

41158 N-1365 DOSE DISTRIBUTION DISPLAY COMPUTER. Okani, S.; Inamura, K. (Nippon Electric Co., Tokyo). NEC (Nippon Elec. Co.) Res. Dev., No. 93, 55-71(Apr. 1969). (In Japanese).

The N 1365 Dose Distribution Display Computer was developed to calculate the absorbed dose in a patient's body by irradiation and to workout the isodose curve immediately so as to enable doctors to make treatment plans and records accurately and quickly. The new computer is especially intended to calculate the working parameters which are best suited for radiotherapy machines and which are needed to obtain an isodose curve according to the patient's case. It consists of a central processor of the NEAC-3100 digital electronic computer and such peripheral equipment as specially designed input equipment, a CRT display unit and a digital plotter. The program for dose calculation is pre-stored in the central processor depending upon the type of radiotherapy machine and the parameters, including portal integrated dose, field size, the distance from the skin surface to tumor, angle of irradiated direction, wedge filter angle and thickness of body and so on are set by the digital switches on the input equipment. Ten ports of 11 input parameters per port, can be set. We have computed an iso-dose curve of a 6 MeV Linac (linear accelerator) x rays at 2.5 mm mesh intervals, by using a 16-inch

CRT, and have succeeded in displaying the curve 2 to 3 seconds per port. The experiment has shown a possibility of use of the new computer in clinical medicine and discussion has arisen as to how a computer should be introduced in the field of radio therapy in future. (auth) (NSA of Japan)

41159 NOTES ON THE TUNING OF A PULSED NMR SPECTROMETER. Antoniak, Waldemar; Chmielewski, Jerzy (Inst. of Nuclear Research, Warsaw). Nukleonika, 14: 81-6(1969).

The amplitude of a NMR free precession signal, which follows high frequency pulses, as a function of the value of the magnetic field H_0 was investigated and the effect of the input circuit mistuning on the NMR free precession and spin echo signals was taken into account. The results of investigation are summarized and a setting-up procedure for pulsed NMR spectrometers is suggested. (auth)

41160 SPECTRAL DENSITY FUNCTION METHOD APPLIED TO THE ANALYSIS OF FLUCTUATIONS IN INTEGRATORS. Stryszak, Edward (Wojskowa Akademia Techniczna, Warsaw). Nukleonika, 14: 59-66(1969). (In Polish).

The method of calculating the mean-square error in integrator circuits used for measuring the intensity of ionizing radiation is described. All the calculations are based on the spectral density function of the Poisson pulse train. A method of approximating the spectral density by a simple algebraic expression is given, and the results of the numeric calculations as well as the advantages of applying this method are discussed. (auth)

41161 IMPROVEMENTS IN OR RELATING TO ELECTRIC SWITCHES. Whittle, Harry Reed (to United Kingdom Atomic Energy Authority). British Patent 1,159,965. July 30, 1969. Filed Sept. 20, 1965.

It is stated that in the development of clamp and start switches for use in nuclear fusion experiments a need has arisen for switches able to handle at least 20 kV. When closed, the switch must have a very low resistance, a low inductance, and be able to carry at least 100 kA and 1000 coulombs. The switch must also be able to close within 100 μ sec or less, with repetition within a tolerance band of 10 μ sec. The switch described comprises a layer of insulating material held between two expendable electrodes connected to the supply to be switched, the electrodes having a pair of aligned apertures. A rivet of deformable conducting material is provided, which is initially positioned to one side of the insulating layer, with means to force it through the apertures when the switch is to be closed, so that the insulating layer is pierced, and the rivet is deformed so that it expands tightly into the apertures with its ends spread out over the surfaces of the electrodes, to form a low resistance path between the electrodes. The operating means may comprise an electrically conducting coil-operated hammer. The rivet material may be Cu or Al, and the insulating material may be polythene. (UK)

41162 WINDSCALE ON-LINE COMPUTING SYSTEM. Williams, P. E. (Edinburgh Regional Computing Centre); Menzies, D. C. Computer J., 12: 244-50(Aug. 1969).

The Windscale (UKAEA) on-line system at present consists of a central computer, used primarily for batch processing of scientific and commercial projects, and four remote terminals used mainly for the analysis of experimental data. Two of the terminals are connected directly to reactor instrumentation. The system and its method of operation are described, and operating experience to date and the usefulness of such a system are discussed. (auth) (UK)

41163 ULTRA HIGH VACUUM FATIGUE EFFECTS IN CHANNEL ELECTRON MULTIPLIERS. Timothy, Adrienne F.; Timothy, J. G. (University Coll., London. Mullard Space Science Lab., Dorking, Eng.). J. Phys., E (London), 2: 825-8(Sept. 1969).

The performance of seven Mullard channel electron multipliers and one Bendix magnetic electron multiplier was studied for a period of several thousand hours at a pressure of 2 ntorr. Reductions in the mean overall gain of the magnetic electron multiplier by a factor of four, and for the Mullard instrument by factors of ten to one hundred, were observed. Storage under vacuum and at atmospheric pressure showed the fatigue effect to have both a reversible and a nonreversible component. The effect of loss of gain on the response of the multipliers when used as satellite xuv photon detectors is discussed. (auth) (UK)

41164 HIGH FREQUENCY GENERATOR FOR INTRACEREBRAL THERMAL STIMULATION. Kadziela, W.; Tomaszewski, R. (Copernicus Univ., Torun, Poland). Acta Biol. Exp., Pol. Acad. Sci., 28: 245-51(1968).

Effects of microwave radiation on the brain were studied by the use of a specially constructed generator (3 MHz) for intracerebral thermal stimulation. Its maximum power was 2.5 W, regulated from zero, and it contained a thermoammeter and voltmeter for the stimulation current. Measurements of intracerebral temperature increase in relation to power of the stimulating current were carried out in rabbits. To control the operation of the generator and to measure the temperature increase of the brain near to the thermode in relation to the heating current, experiments were performed with a chronically implanted thermode and with a copper-constantan thermocouple. They were both introduced into the brain, according to stereotaxic coordinates, 13 mm below the surface. The thermode was 1 mm distant from the thermocouple. The intracerebral thermal stimulation was performed with simultaneous measurements of brain temperature and current power. The intracerebral temperature increase in relation to power was approximately linear. To increase the temperature of the hypothalamus by 1°C, 1 mm from the thermode, a power of from 190 to 276 mv-a was necessary. (BBB)

41165 POSITIVE ION SOURCE FOR USE WITH A DUOPLASMATRON. Cleland, Marshall R.; Thompson, Chester C. Jr. (to Radiation Dynamics, Inc.). U. S. Patent 3,458,743. Filed Dec. 19, 1966.

A duoplasmatron ion source is provided employing a flat, annular focusing electromagnet housed in an aluminum housing. The housing is located between metallic rings supporting a flat anode and a conical intermediate electrode, and forms the ion chamber wall in this region. The magnet is cooled by conduction to the rings which are cooled by coolant flowing through internal passages. To increase x-ray absorption the outer conical surface of the intermediate electrode is enclosed, except at the tip opposite the anode, by a metallic insert. The anode is provided with a center insert which, during assembly of the source, is replaced by an aligning tool permitting rapid, precise alignment of the elements. The cathode comprises four elements encircling the axis of the ion source, the elements being electrically connected as a bridge circuit. A short glass chamber wall between the top plate and intermediate electrode permits viewing of the filament region. To permit effective evacuation of the exterior region, the ion extractor assembly employs a large diameter cylindrical extractor. To maintain a constant mean divergence with changes in beam current, the surface of the anode opposite the extractor is conical with an apical angle of at least 60° and a diameter of the order of the extractor. (Offic. Gaz.)

41166 EFFECT OF POLE PIECE PARALLELISM ERRORS ON THE IMAGE OF MASS SPECTROMETERS WITH π RADIAN DEFLECTION. Ioanoviciu, D. (Institutul de Fizica Atomica, Cluj). Stud. Cercet. Fiz., 21: 383-8(1969). (In Rumanian).

The ion trajectories in the field of slightly tilted pole faces were computed. An additional aberration as cross term of angular aperture and field perturbation coefficient results. The magnitude of this aberration enables to prescribe tolerances in pole piece parallelism and their machining. (auth)

41167 APPLICATION OF MULTICHANNEL ANALYZERS IN ISOTOPE TECHNIQUE. Adorjan, Bence; Hinsenkamp, Alfred; Mannhardt, Endre (MTA Koezponti Fizikai Kutato Intezet, Budapest). Atomtech. Tajek., 11: 681-3(Dec. 1968). (In Hungarian).

The multichannel analyzers elaborated at the Central Research Institute for Physics provide considerable advantages in isotope techniques compared to one-channel equipment. Isotopes of short half-life demand quick measurements while small activities require very sensitive measurements. The analyzers provide for the supplementary functions, which make measurements quicker and easier. (auth)

41168 SIMPLE MASS SPECTRUM LINEARIZER. Meisels, G. G.; Giessner, B. G.; Leger, L. J. (Univ. of Houston, Tex.). Rev. Sci. Instrum., 40: 1224-6(Sept. 1969).

An inexpensive modification of a commercial mass spectrometer is described which permits linear display of ion intensity vs m/e on an X-Y recorder. Its evaluation shows that the major limitations arise from recorder specifications. For magnetically scanning instruments, mass assignments can be made within ± 0.006% utilizing the maximum zero offset of 85% of the largest mass of interest. Peak positions are independent of scanning speed up to 30 m/e units/min and can be assessed within 0.1% of the mass range covered. (auth)

41169 EVAPORATED SILVER-ALUMINUM THERMOCOUPLES FOR LOW TEMPERATURE MEASUREMENT. Bailey, Sheila B.; Richard, Roy T.; Mitchell, E. N. (Univ. of North Carolina, Chapel Hill). Rev. Sci. Instrum., 40: 1237-8(Sept. 1969).

The thermocouples discussed were used to measure the temperature of Permalloy films on glass substrates. It was necessary to know the temperature of the Permalloy surface during cycling between 300 and 4.2°K. Since this was done repeatedly it was imperative that the thermocouple recycle accurately. The silver-aluminum thermocouple was found to have this stability as well as being easy to evaporate, reproducible, and relatively linear above 20°K. (auth)

41170 FLEXIBLE CHANNEL MULTIPLIER. Hayashi, Tomonao (Tokyo Univ.); Hashimoto, Masashi; Yamamoto, Kazumasa. Rev. Sci. Instrum., 40: 1239-40(Sept. 1969).

A study on a flexible channel multiplier made of electron conductive polymer is reported. The secondary electron yield of the material used is shown to be 2.0 at 250 eV in primary electron energy. (B.G.D.)

41171 PHOTOMULTIPLIER FOCUS CONTROL. Lavoie, Louis (Univ. of Chicago). Rev. Sci. Instrum., 40: 1245-6 (Sept. 1969).

The characteristics of photomultiplier tube input focusing were studied using a flying spot scanner in order to determine how the photoelectron collection efficiency is affected as the voltage on the focus elements is varied. This focus optimization was compared for maximum uniform amplitude over the maximum area, which is called geometric optimum, with focus adjusted for maximum signal pulse height when the cathode is uniformly illuminated with scintillation light. (auth)

41172 PULSED PHOTOMULTIPLIERS. De Marco, F.; Penco, E. (CNEN, Rome). Rev. Sci. Instrum., 40: 1158-60 (Sept. 1969).

Three methods of switching photomultipliers (pulsing of the first dynodes, pulsing of the whole chain, pulsing of the last dynodes) have been tested and compared on the grounds of a good on/off ratio, a low electrical noise, and a short risetime of the gain. The measurements and the results of this research are reported and the best one was the one for which an on/off ratio of about 300, a risetime of 20 nsec, and a very low electrical noise was obtained. (auth)

41173 IMPROVEMENT OF THE SIGNAL-TO-NOISE RATIO OF PHOTOMULTIPLIERS FOR VERY WEAK SIGNALS. Topp, J. A.; Schroetter, H. W.; Hacker, H.; Brandmueller, J. (Univ., Munich). Rev. Sci. Instrum., 40: 1164-9(Sept. 1969).

For the photoelectric detection of Raman spectra excited with a He-Ne laser, the dark current of an EMI 9558 QA photomultiplier is reduced by magnetic defocusing of the electrons originating from the inefficient part of the photocathode. A lightpipe cone concentrates the light signal to a spot of 2.7 mm diameter and enhances the quantum efficiency of the photocathode by multiple reflection. A pulse counting system with a deadtime of less than 100 nsec is described and compared with dc detection. It is now possible to detect signals with a power of less than 10^{-17} W or less than 35 photons/sec at 650 nm with a time constant of 1 sec. The improvement in signal-to-noise ratio is demonstrated with the Raman spectrum of polycrystalline azobenzene. (auth)

41174 APPARATUS FOR THE PRODUCTION OF VERY SOFT X RAYS AT HIGH INTENSITY. Clark, B. C.; Gross, W. (Columbia Univ., New York). Rev. Sci. Instrum., 40: 1178-82(Sept. 1969).

An apparatus has been developed for producing high intensity x-ray beams at constant potential between 1 and 6 kV. An electron beam produced by a specially designed electron gun of the Pierce-Müller type bombards a rotatable target. Beam currents up to 500 mA have been achieved. The design permits the positioning of each of four different target materials into the electron beam. Targets are prepared by vacuum evaporation of the desired material onto a target block. A thin window (beryllium foil and Mylar film) provides an exit path for the x rays and has acceptable transmission at energies above 1.5 keV. Such very soft x rays are strongly absorbed in air, but may be brought through a helium path and plastic foil exit window to a test system for investigation of their effects. (auth)

41175 MINIATURE LOW ENERGY X-RAY CALIBRATION TUBE. Grader, R. J.; Scudder, J. K.; Tindall, W. E. (Univ. of California, Livermore). Rev. Sci. Instrum., 40: 1160-1(Sept. 1969).

The design and operation of a miniature x-ray tube used as a calibration source for a rocket borne x-ray astronomy experiment are described. The tube utilizes a miniature lamp filament and a 0.05 mm aluminum foil as a transmission target. Anode current of 1 μA and accelerating potential of 4 kV produce approximately 1000 1.48 keV photons/sec. Shelf life of the tube is greater than three months and the operating life is several hours. (auth)

41176 METASTABLE ATOM DETECTION SYSTEM FOR GROUND STATE ATOM BEAMS. Winicur, Daniel H.; Rodgers, Wayne E.; Knuth, Eldon L. (Univ. of California, Los Angeles). Rev. Sci. Instrum., 40: 1192-5(Sept. 1969).

A metastable atom detection system for ground state atom beams has been developed which differs from preceding systems in that the atom beam (not the electron beam) is modulated, the atom beam is velocity selected, a Bayard-Alpert type exciter is used, and an improved signal enhancement system is employed. An argon beam density five orders of magnitude lower than the background gas density has been measured with a signal-to-noise ratio greater than unity. (auth)

41177 ANALYSIS INSTRUMENTATION. VOLUME 6. Proceedings of the Fourteenth Annual Analysis Instrumentation Symposium, held in Philadelphia, Pennsylvania, May 19-22, 1968. Fowler, Lewis; Connelly, B. L.; Krueger, R. G. (eds.). New York, Plenum Press, 1969. 381p. (CONF-680550).

Separate abstracts were prepared for 3 of the 41 papers presented. The remaining 28 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 41084, 41088, and 42251.

41178 AUTOMATION AND INSTRUMENTATION, 1968. VOLUME 1. Proceedings of the X International Automation Conference Held in Milan from November 20th to 26th, 1968. Milan, Federation of Scientific and Technical Associations, 1968. 870p. (In Italian and English). (CONF-681130-(Vol.1)).

Fifty-nine papers on automatic control of instruments, equipment, and machinery are presented. An abstract was prepared for one paper on a vacuum gage. (B.G.D.)

For an abstract of the individual paper see: 41179.

41179 IONIZATION GAUGE CONTROL UNIT. Redi, R. (Officine Galileo, Florence). pp 363-8 of Automation and Instrumentation, 1968. Vol. 1. Milan, Federation of Scientific and Technical Associations, 1968.

From 10th International Automation Conference, Milan, Italy. See CONF-681130-(Vol.1).

A new ionization gauge control unit for vacuum measurement is described. This unit represents a new development in the field of vacuum gauges. If the grid current of a Bayard-Alpert gauge is maintained constant, the collector current is proportional to the vacuum value. A very simple circuit is used to keep the grid current constant as the vacuum value varies. A FET electrometric amplifier is employed to measure the collector current. The control unit is protected by a power cut-out circuit operating when the collector current exceeds the instrument full-scale value by at least 20%. A digital recorder that may be used in place of the analog recorder is also described. (auth)

41180 AUTOMATION AND INSTRUMENTATION, 1968. VOLUME 2. Proceedings of the X International Automation Conference Held in Milan from 20th to 26th November, 1968. Milan, Federation of Scientific and Technical Associations, 1968. 557p. (In Italian and English). (CONF-681130-(Vol.2)).

Included are 42 papers on applications of automatic controls, instrumentation, and electronic computers in chemical processing, electrical and nuclear energy production, mechanical and metallurgical processes, medical engineering and bio-cybernetics, and real time integrated management information systems. A separate abstract was prepared for one paper on nuclear reactor control. (H.D.R.)

For an abstract of the individual paper see: 43167.

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 41046.

41181 (COO-1624-16) DETERMINATION OF TRANSISTOR CHARACTERISTICS AFTER NEUTRON RADIATION. Azarewicz, J. L.; Beckmann, T. D.; Bereisa, J. Jr.; Goben, C. A. (Missouri Univ., Rolla. Space Sciences Research Center). 1969. Contract AT(11-1)-1624. 4p. (CONF-690704-6). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

A model was developed for the neutral base region of a transistor using closed form solutions of the continuity equation which accounts for both the effect of recombination and built-in electric field in the base region. This model was applied to the study of neutron radiation effects in double diffused devices and predicts the steady state concentration of excess minority carriers in the base region as a function of injection, electric field, distance, and neutron fluence. Predictions are presented graphically. (W.H.K.)

41182 (COO-1624-17) INVESTIGATION OF DEFECT CLUSTERS IN SILICON P-N JUNCTIONS. Irani, C. H.; Johnson, P. E.; Van Meter, J. L.; Goben, C. A. (Missouri Univ., Rolla.

Space Sciences Research Center). 1968. Contract AT(11-1)-1624. 4p. (CONF-690704-7). Dep. CFSTI.

From Conference on Nuclear and Space Radiation Effects, University Park, Pa.

A method for observing the neutron-induced defect cluster in the p–n junction depletion region is briefly discussed. The effects of an electric field on the mobility of neutron-induced defects in silicon were studied, and the results are presented. (W.H.K.)

41183 GAMMA-RADIATION SURFACE EFFECTS ON TRANSISTORS. Aoki, Hiroyuki (Nippon Telegraph and Telephone Public Corp., Tokyo). Jap. J. Appl. Phys., 8: 959(July 1969).

Surface effects on silicon epitaxial planar transistors induced by gamma radiation with a 3000 Curie cobalt-60 source were studied by measuring degradation of common emitter dc gain at collector currents from 1 μA to 10 mA. The study included particularly the effects of dose, dose rate, and transistor type. (B.G.D.)

41184 RADIATSIONNYE EFFEKTY V POLUPROVODNIKAKH I POLUPROVODNIKOVYKH PRIBORAKH. (Radiation Effects on Semiconductors and Semiconductor Instruments). Vavilov, V. S.; Ukhin, N. A. Moscow, Atomizdat, 1969. 312p.

Theoretical concepts of the nature of radiation induced defects in semiconductors by fast electrons, γ quanta, neutrons and heavy charged particles are discussed. Experimental studies of radio-induced defects, stability and annealing of semiconductors, and radiation control of semiconductor properties are described. Also, radiation effects on transistors and semiconductor diodes and the effects of pulsed radiation on semiconductor instruments are detailed. (312 references.) (R.V.J.)

41185 RADIATION DAMAGE IN THE SILICON SOLAR CELL. Takami, Yasukiyo (Rikkyo Univ., Tokyo); Moriguchi, Yoshiro. Lect. Space Sci. Technol. Meet., 147-50(Jan. 1968). (In Japanese).

The radiation damage to silicon solar cells is one of the most important factors which determine its life and stability in space flight. Fission neutron and 20-MeV proton damage was studied. For operation under a constant voltage load, it was found that 10 ohm-cm resistance is superior. (TSS) (NSA of Japan)

41186 RADIATION OR RELIABILITY: WHICH COMES FIRST. Electron. Eng., 28: 10, 13(Apr. 1969).

Hardening components so that they can function in a radiation environment may require measures that conflict with high reliability practices. A table shows areas where such cross-purposes exist. Parameters examined include: voltage, current, frequency, masking, base width, internal base resistance, bonding, and materials. Power transistors are difficult to harden against radiation because of their construction, i.e., large geometries, low doping, and high voltages. Also, the large areas cause increased transient γ photocurrents to flow, and the low gain-bandwidth products combined with thick base widths produce postneutron bombardment β degeneration. The higher $V_{CE(SAT)}$ values and large package size also impede hardening. Desirable component characteristics for hardening include small geometries: the smaller the device's active volume, the less the effects of photocurrent flow. High-level doping raises postneutron resistivity. Low voltages accommodate higher doping levels. Gold doping strengthens saturation characteristics and lessons β sensitivity to neutrons. High current densities and high grain-bandwidth products improve postneutron gain capability. Other hardening measures include dielectric isolation, minimum internal base resistance and base widths, and double-diffused epitaxial construction. (BBB)

41187 RADIATION TOLERANCE OF BIPOLAR AND FIELD EFFECT TRANSISTORS AS A FUNCTION OF LIFETIME AND DOPING. Buchanan, B. L.; Dolan, R. P.; Shedd, W. M. (Air Force Cambridge Research Labs., Bedford, Mass.). Trans. Met. Soc. AIME, 245: 499-503(Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

Analytical expressions are derived from empirical data relating the basic physical device parameters to the radiation dose. To put in perspective and justify the approach taken, the overall problem and methods of attempted solution of radiation damage to transistors in a missile or satellite environment is briefly examined. The main emphasis is on a new criteria for neutron radiation hardness and the device design implications resulting from using this criteria. Contrary to other derived criteria, the derived bipolar hardness relation depends mainly on the initial lifetime rather than the base transit time. It is shown, that contrary to previously accepted beliefs, the inherent attainable radiation tolerance of JFET's is at least a factor of ten greater than the radiation tolerance of bipolars. Experimental results on JFET's designed for maximum neutron radiation tolerance are presented. The accuracy, utility, and range of possible validity of various published lifetime and carrier removal damage constants are discussed. (auth)

41188 SEMICONDUCTOR DEVICE HAVING IMPROVED RESISTANCE TO RADIATION DAMAGE. Ross, Bernd (to Globe-Union Inc.). U. S. Patent 3,462,311. Filed May 20, 1966.

A semiconductor device having a drift field therein for increasing minority carrier diffusion length is described. The drift field is established either in an epitaxially grown region or in the bulk by diffusion of lithium. This presence of the drift field and/or the lithium makes a photovoltaic solar cell especially resistant to radiation damage. (Official Gazette)

41189 EFFECT OF NEUTRON RADIATION ON AN IMPATT DIODE. Chaffin, Roger J. (Sandia Lab., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Microwave Theory Tech., MTT-17: 119-20(Feb. 1969).

Data are presented that show an increase in efficiency of an IMPATT diode after neutron irradiation. A theory explaining this effect is derived and compared with the experimental results. Data are also presented on variations of other diode parameters with neutron irradiation. The IMPATT oscillator studied was a commercial silicon CW x-band unit (Varian BIO-001), with an output power nominally of 50 mW at 11 GHz. Except for a slight initial decrease in efficiency, the diode efficiency continued to increase with neutron irradiation up to the point where it failed catastrophically (10^{16} neutrons/cm^2). This effect was interpreted as a modulation of the width of the undepleted layer in the diode with flux. The undepleted material acted essentially as a positive resistance in series with the diode's equivalent resistance, thus lowering the efficiency of the device. An equation was developed and was interpreted as showing that under neutron irradiation the physical dimensions of the series resistor (undepleted material) shrink while its resistivity increases. This model for the behavior of the diode's series resistance was verified by observing the variation of efficiency with neutron flux. The r-b spectrum width remained essentially unchanged up to the point of failure. The 3-dB width was $\sim$30 KHz. The reverse breakdown voltage increased with increasing radiation up to the point of failure. The preradiation value was -70 V, and after an integrated dose of 5×10^{15} neutrons/cm^2 it was -79 V. This was due to the fact that the n region in the silicon was becoming intrinsic. The operating frequency of the diode remained essentially unchanged with irradiation. This was because the frequency was determined by the oscillator cavity rather than the diode and the metal cavity was not affected by the neutron fluence level used. (BBB)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 40591.

Basic Processes

Refer also to abstracts 40582, 40604, 40607, 41236, and 43181.

41190 (CONF-670338, pp 103-12) MEDICAL APPLICATIONS OF RADIOISOTOPES IN LATIN AMERICA. Maass, Roberto (Comision Nacional de Energia Nuclear, Mexico City).

The practice of clinical medicine is exhibiting increasing need of information with regard to body structure and functions in both the normal state and in disease. Radioactive tracers are in many ways the appropriate answer to this need since methods using these elements tend to be fast, accurate, and simple. The new speciality of nuclear medicine was developed around these activities. Latin American countries have also felt the necessity of raising medical standards to satisfy these new demands. In some cases, socialized medicine was able to meet the challenge in providing expensive and advanced attention for the large part of the population with low income. The practice of nuclear medicine has, however, limitations and shortcomings. There is, for instance, a lack of trained specialists. The instruments are often more expensive than in heavily industrialized countries. The supply of radioactive materials becomes difficult because of economic, administrative, and physical reasons. Finally there are difficulties in obtaining maintenance services and there is a negative attitude of some clinicians who are reluctant to adapt themselves to the new approaches to medical problems. In some countries there is an important and active trend to solve these situations. In many cases the solutions have proven to be feasible and successful. Nuclear medicine in Latin America has many limitations but steps were undertaken to solve them and in some countries there have been outstanding advances in this regard. (auth)

41191 (CONF-670338, pp 113-26) MEDICAL APPLICATIONS OF RADIOISOTOPES IN CHILE. Litvak L., Jorge (Comision Chiltena de Energia Nuclear, Santiago).

The medical applications of radioisotopes in Chile are discussed. The use of radioisotopic tracers in basic research, in clinical investigation, in diagnosis, and therapy, as well as in the facilities for teaching these techniques is described. Radioisotopes are currently used in four areas related to medicine and biology: As tracers in basic research, they are widely used in the Medical Schools of the University of Chile, Catholic University and University of Concepción, and in the Faculty of Sciences of the University of Chile. They are used in clinical investigation at hospitals having an active radioisotopes laboratory. Some of the lines of investigation are: ^{45}Ca and ^{85}Sr kinetics and metabolic bone disease, metabolic studies of endemic goiter, and manganese metabolism in chronic exposure to manganese. Clinical use of radioisotopes for diagnosis and treatment in Chile started in 1954. Several hospitals have active radioisotope laboratories. In general, diagnosis and therapy relate to the thyroid gland (^{131}I uptake, PB ^{131}I scannings, treatment of thyrotoxicosis and thyroid cancer), blood (red cell survival, ^{59}Fe kinetics, blood volume, treatment of polycythemia), and gastroenterology (fat absorption, ^{47}Ca absorption, liver and spleen scanning). The curricula of medical schools, nursing schools, and the school of Medical Technology of the University of Chile include courses in applications of radioisotopes. One of the Medical Centers of Santiago has developed a permanent training course for Latin American physicians. Twenty-six persons from different countries have taken the course for periods ranging from 7 to 24 months. (auth)

41192 Cs, K, Sr, AND Ca TRANSPORT IN TWO DIFFERENT PLANT SPECIES. Resnik, M. C.; Lunt, O. R.; Wallace, A. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Soil Sci., 108: 64-73(July 1969).

Bush bean and barley plants were exposed to factorial combinations of potassium and calcium in which one or the other was labeled with ^{42}K or ^{45}Ca. Other experiments were conducted with ^{137}Cs and ^{85}Sr. Attempts were made to exclude from analysis those radioactive isotopes associated with the free space and cation-exchange sites in roots. Calcium accumulation in roots appeared to be independent of, but translocation to shoots was dependent upon temperature at 10^{-3} and 10^{-5} $\underline{M}$ calcium. Data at 10^{-1} $\underline{M}$ were inconclusive. Temperature dependency for calcium translocation to shoots decreased with increasing potassium. Potassium accumulation and translocation were temperature dependent particularly with the two low concentrations. The temperature dependency for potassium accumulation in bush bean roots increased with increasing calcium but the reverse occurred in both species for translocation to shoots. Cesium accumulation was temperature dependent for bush bean as was translocation for both species. Cesium translocation, however, did differ from that of potassium. At low temperature, calcium levels greatly inhibited potassium accumulation by roots in bush beans but to a much lesser extent in barley. The effect for cesium was almost absent in barley. Little effect was observed on translocation to shoots. This resulted in a large temperature-calcium level interaction on the proportion of potassium and cesium translocation to shoots in bush beans. Calcium translocation to tops increased with increasing calcium levels much more at 24° that at 0°C. Barley with a lower root cation-exchange capacity than bush bean tended to accumulate more potassium and cesium than bush bean particularly at the low temperature and at the highest calcium level. Bush bean tended to accumulate more calcium than barley and this in general was most pronounced at the lowest calcium level. (auth)

41193 MEASUREMENT OF TRITIATED ORGANIC COMPOUNDS IN THE PRESENCE OF TRITIATED WATER IN URINE. Pagnotto, Leonard D.; Killian, Charles B. (Massachusetts Dept. of Labor and Industries, Boston. New England Nuclear Corp., Boston). Amer. Ind. Hyg. Ass. J., 30: 407-12(July-Aug. 1969).

A simple procedure is described for extracting tritium-labeled organic metabolites from urine by an alcohol-ether extracting solution. The extractant is evaporated to dryness, dissolved in alcohol, and analyzed for tritium. The procedure permits a separation of tritium-labeled organic metabolites and other ether-soluble substances from tritium-labeled water in urine. Once the tritium activity of these fractions is known, then the specific mode of metabolism of these substances can be employed more effectively in calculations of internal body dose. An application of the procedure is given for an accidental exposure from which a mixture of tritium-labeled styrene and tritium-labeled water was absorbed. (auth)

41194 RADIOIMMUNOASSAY OF HUMAN PLASMINOGEN AND PLASMIN. Rabiner, S. Frederick; Goldfine, Ira D.; Hart, Arlene; Summaria, Louis; Robbins, Kenneth C. (Michael Reese Hospital, Chicago). J. Lab. Clin. Med., 74: 265-73(Aug. 1969).

A radioimmunoassay for human plasminogen and/or plasmin was developed with highly purified human plasminogen and plasmin and specific rabbit antibodies. For assay procedure, ^{125}I-labeled plasminogen (0.01 μg) was added to plasminogen antibody. To this was added either standard or sample followed by goat anti-rabbit antibody. After incubation for 72 hr at 4°C, suspension was centrifuged, and precipitate was counted. Unknowns were read off a standard curve prepared with purified plasminogen or plasmin. The range of the standard curve was 0.02 to 2.5 μg. When the assay system was run at pH 8.9, a similar slope was obtained for both plasmin and plasminogen. At pH 7.4, despite the fact that the plasminogen curve changed very little, the slope of the plasmin curve flattened. Reproducibility was excellent, and day-to-day variation was small. When 100 μg of plasminogen were added to 10 plasmas, the mean recovery was 90% (range 75 to 108%) Plasminogen could not be detected in saliva or urine. There was no reaction with plasma from dog, beef, goat, chicken, lungfish, or mud puppy, and slight cross-reaction with plasma from rhesus macaque, stump-tailed macaque, pig-tailed macaque, and baboon. The mean value for 28 healthy adults was 206 ± 36 μg per milliliter (S.D.). Although mean for females (216 ± 35 μg per milliliter [S.D.]) seemed higher than males (194 ± 35 μg per milliliter [S.D.]), this difference was not significant ($p > 0.10 < 0.20$). Simultaneous caseinolytic assays were always lower than radioimmunoassays. The mean of 40 assays on plasma from infants aged 0 to 10 days was 90 ± 24 (S.D.). This was significantly ($p < 0.001$) lower than adult values. These rose with age but were still low at age 6 months. In a series of experiments on hemophiliacs, epsilon aminocaproic acid administration was found to lower plasminogen. (auth)

41195 STUDIES ON LIPID METABOLISM. 2. ON METABOLISM OF LIVER LIPIDS WITH ^{14}C-LABELED PALMITATE AND LINOLEATE. Suzuki, Akihiro (Sapporo Medical Coll.). Sapporo Igaku Zasshi, 34: 235-40(Oct. 1968). (In Japanese).

Using 1-^{14}C-palmitate and 1-^{14}C-linoleate, the metabolism of liver lipids was investigated with normal and ethionine-treated rats. In normal rat liver it was found that specific radioactivities (SA) of liver lipids were almost the same at 20 min after intravenous injections of each tracer and were present in the following order: diglyceride (DG) > triglyceride (TG) > phospholipids (PL). In ethionine-treated rats, it was observed that the order of SA was the same as in the normal. It was, however, recognized that SA of each lipid was not always the same in the latter as in the former, that is, SA of TG of the latter was much lower than that of the former and SA of PL was also lowered in the ethionine-treated animal. These results indicate that the decline in esterification of lipids is caused in the proceeding of the fatty liver. To clarify the interconversion of fatty acid, they were separated into saturated (I), monoenoic (II), dienoic (III) and polyenoic (IV) by thin layer chromatography of silica gel impregnated with silver nitrate and the radioactivity in each fraction was determined. In the case of 1-^{14}C-palmitate, almost 90% of the radioactivity recovered as fatty acids were present in (I) and a little in (II) and (IV). With 1-^{14}C-linoleate, (IV) from NEFA and DG showed the highest radioactivity among the four fatty acid fractions, respectively, while (IV) from PL had strong radioactivity as well as (III) from PL. On the contrary, over 90% of the radioactivity found in fatty acid from TG was present as (III). (I) and (II) from each lipid fraction also contained radioactivity, though it was low. From the results obtained by 1-^{14}C-linoleate it can be said that linoleate was actively converted into polyenoic acid, especially to arachidonic acid and also the polyenoic acids thus produced were incorporated into PL and DG actively, but not to TG. (NSA of Japan)

41196 EXPERIENCE WITH A SIMPLIFIED METHOD OF RADIOISOTOPIC ASSAY OF SERUM VITAMIN B_{12}. Britt, R. P.; Bolton, F. G.; Cull, A. C.; Spray, G. H. (Churchill Hospital, Oxford). Brit. J. Haematol., 16: 457-64(May 1969).

A simplified radioisotope method for the assay of serum vitamin B_{12} is described. Cyanocobalamin (^{57}Co-labeled) solution (0.5 ml) is added to all standards and extracts and after mixing, 0.5 ml diluted normal serum is added. The tubes are placed for 1 hr in a mixer and 2 ml of albuminized charcoal suspension is added. Mixing is continued for 30 min. All tubes are centrifuged for 3 min at 3000 rpm and 4 ml supernatant is transferred to 10-ml plastic tubes. Each tube is counted in a scintillation well counter for 100 sec. After subtraction of background radioactivity a standard curve is plotted on arithmetic graph paper. The counts of the serum extract tests referred to this curve give a direct reading of the vitamin B_{12} level in pg/ml. Results obtained by this method correlated well with those obtained by microbiological assay using Lactobacillus leichmannii; reproducibility was of the same order and the range of values obtained in normal subjects fell within the accepted range. There was no difficulty in detecting clinical vitamin B_{12} deficiency. (BBB)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 40569, 40585, 41192, 41264, 41301, 41304, 41306, 41316, 41466, and 41609.

41197 (COO-119-239) CESIUM, RUBIDIUM, AND POTASSIUM METABOLISM: STUDIES OF MUSCLE SEEKING RADIONUCLIDES. (Utah Univ., Salt Lake City. Radiobiology Div.). Dec. 1968. Contract AT(11-1)-119. 60p. Dep. CFSTI.

Two separate abstracts were prepared for inclusion in NSA. A third paper concerns potassium content of persons having Duchenne muscular dystrophy. (C.O.)

For abstracts of individual papers see: 41198 and 41199.

41198 (COO-119-239, pp 2-29) RETENTION OF INGESTED ^{83}Rb AND ^{137}Cs BY FOUR PATIENTS WITH DUCHENNE MUSCULAR DYSTROPHY. Lloyd, Ray D.; Mays, Charles W.; Zundel, Wayne S.; Taysum, David H.; Pendleton, Robert C.; Hupf, Homer B.; Tyler, F. H. (Utah Univ., Salt Lake City. Radiobiology Div.).

Since normal muscle tissue can incorporate rubidium and cesium ions, a double tracer of ^{83}Rb plus ^{137}Cs was administered orally to 4 boys (aged 13–19 years) afflicted with Duchenne muscular dystrophy. The double tracer was also given to 1 healthy man. Total-body retention was determined from 0 to 250 days after administration. Blood samples and excreta were also analyzed for radioactivity. About 80% of the excreted Rb and nearly 90% of the excreted Cs was in the urine for each of these 5 subjects. Equivalent biological half-times for Rb and Cs, respectively, were 57 and 130 days in the healthy adult, but averaged only 25 and 16 days in the dystrophic boys. The enhanced elimination of Rb and especially Cs by the dystrophics was mainly because their blood contained an elevated fraction of the retained body burden. Kidney clearance of both Rb and Cs from the blood plasma was in the order of 10 liters per day for all 5 subjects. These data are consistent with the concept that a cellular defect, resulting in altered membrane permeability, may account for the short half-times of Rb and Cs in patients with muscular dystrophy. (auth)

41199 (COO-119-239, pp 40-60) CESIUM AND RUBIDIUM STUDIES IN MICE. Taysum, D. H.; Lloyd, R. D.; Mays, C. W.; Johnson, B. W.; Woodbury, Catherine McBride; Taylor, G. N. (Utah Univ., Salt Lake City. Radiobiology Div.).

Total-body retention of ^{137}Cs or ^{134}Cs administered by gastric gavage to female C-57 B1 mice was greater in older animals. Equivalent biological half-times for cesium were 2.2 days in 68 day-old mice, 2.6 days in 121 day-old mice, 2.8 days in 152 day-old mice, and 3.6 days in one year old mice. In one 85-day-old mouse, the equivalent biological half-time for similarly administered ^{83}Rb was 2.9 days but it was 3.3 days in 5 mice 121 days of age. Pregnancy decreased the excretion rate of both ^{83}Rb and ^{134}Cs in one animal that conceived and delivered a litter of young following double-tracer administration. Concentration of ^{83}Rb in liver exceeded that in the muscle of 2 mice sacrificed one and ten days after administration. Skeletal ^{83}Rb concentration was 66% and 76% that of muscle ^{83}Rb concentration in these two animals. (auth)

41200 (RLO-581-32) STUDIES OF GENETIC ALTERATIONS IN HUMAN CELLS AND MOLECULES AND THE FACTORS INFLUENCING THEM. Progress Report, August 1, 1968–July 31, 1969. (Oregon Univ., Portland. Div. of Experimental Medicine). Contract AT(45-1)-581. 56p. Dep. CFSTI.

The partial specific volume and the molecular weight of the phytohemagglutinin of Phaseolus vulgaris were determined. A method for continuous monitoring chromatographic column effluents for glycopeptides and peptides in general, utilizing the Technicon Autoanalyzer, was developed. Data on the structure and biochemistry of glycoproteins are presented. Factors which may influence the response of human lymphocytes to phytohemagglutinin were studied and it was found that even in the absence of other types of leukocytes the dose-response curve remains the same, the concentration of phytohemagglutinin rather than its total amount determines the response, and that relatively stable serum factors are necessary for the response. The effects of different doses of phytohemagglutinin on the synthesis of total protein and RNA of lymphocytes were also studied. The inhibition by D_2O of the transformation of human lymphocytes by phytohemagglutinin and the localization of ^{3}H-phytohemagglutinin within leukocytes in vitro were studied. A workable mitogenicity assay using rabbit blood lymphocytes was developed. This assay will make possible to test whether lymphocytes from rabbits made tolerant to phytohemagglutinin respond to it or not and thus to find out if its mechanism of action is by eliciting an immunological response. The response of lymphocytes from ataxia telangiectasia and from Down's syndrome to phytohemagglutinin were studied. It was found that in both diseases there is a great impairment of the response, but the optimum dose-response curve is normal in both. The time-response curve is normal in ataxia telangiectasia but shows a delayed response in Down's syndrome. It is concluded that in ataxia telangiectasia there are two populations of lymphocytes, a normal one which responds to phytohemagglutinin and an abnormal one which does not. In Down's syndrome there is only one population of lymphocytes which are defective and show a low response to phytohemagglutinin. The subunit dissociation of hemoglobin Rainier was studied as a function of pH and ionic strength and was found that it is affected by pH in the opposite direction than that of hemoglobin Kempsey. A multiple disc pressure ultrafiltration unit has been designed and constructed. This glass ultrafilter can accommodate any number of 3-in. diameter collodion or Diaflo membranes and gives a rate of ultrafiltration of 10 ml per minute per collodion membrane at 30 psi. It is currently used to concentrate rapidly human urinary erythropoietin. (C.H.)

41201 (UR-49-1088) REAPPRAISAL OF THE ACTION OF URANYL ION ON CELL MEMBRANES. Rothstein, Aser (Rochester Univ., N. Y. Atomic Energy Project). July 5, 1969. Contract W-7401-eng-49. 22p. (CONF-690621-1). Dep. CFSTI.

From 2nd Conference on Toxicity, Rochester, N. Y.

Uranyl ion (UO_2^{2+}) penetrates cell membranes slowly, if at all. It does, however, form reversible but stable complexes with phosphoryl and carboxyl ligands on the outer surface of the membrane. The two classes of ligands can be distinguished, in the case of yeast cells, on the basis of affinity and also on the basis of physiological effects. UO_2^{2+} is a particularly effective inhibitor of sugar transport in yeast. Two distinct mechanisms are involved: one, via UO_2^{2+} binding to the phosphoryl sites and one via the carboxyl sites. The phosphoryl sites are involved in a transport pathway involving metabolism. It is sensitive to iodoacetate, has a high specificity for certain sugars, has a high affinity for certain sugars and has a rapid rate of turnover. The carboxyl pathway, in contrast, is insensitive to iodoacetate, has broad specificity, low affinity and slow turnover. These findings and others are compatible with the concept that the phosphoryl pathway is an "uphill" system involving simultaneous transport and phosphorylation of the sugar, with UO$_2^{2+}$ interfering with the phosphorylation. A similar mechanism of sugar transport has been demonstrated in bacteria, with many of the biochemical details elucidated. UO$_2$ also binds to ligands on the surfaces of animal cells, interfering with repolarization in muscle and with sugar transport in intestine and kidney. The mechanism of sugar transport is, however, different in animal cells so the specifics of the UO$_2^{2+}$ effect must also be different. (auth)

41202 INFLUENCE OF IONIZING RADIATION, SULFHYDRYL COMPOUNDS, AND HYPOXIA ON THE PHOSPHORYLATION OF THYMIDINE IN THE RAT THYMUS AND SPLEEN. Filippovich, I. V.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Radiobiologiya, 8: 800-5(Sept. 1968). (In Russian).

It was shown that the administration of AET and MEA to rats exposed to lethal doses of x radiation 10 to 15 min before decapitation of the animals sharply inhibits the phosphorylation of thymidine in extracts from the thymus and spleen of rats. The inhibiting effect is not manifested 3 hrs after the administration of the preparations. The injection of the radiosensitizers, dl-penicillamine and β-mercaptoethanol, 10 to 15 min before decapitation of the animals also has an inhibiting effect on the phosphorylation of thymidine; however, after 3 hrs the inhibiting effect of the compound is not removed. Exposure of the rats to an atmosphere with 5% oxygen and 95% nitrogen leads to a sharp inhibition of phosphorylation of thymidine in the spleen. The mechanisms of the inhibiting effects of aminothiols and hypoxia differ. On the basis of the results obtained from the addition of aminothiol protectors to the incubation medium in vitro, it may be assumed that the inhibiting effect of AET and MEA on the phosphorylation of thymidine in the spleen in experiments in vivo is due to their direct intervention in the process of phosphorylation. The suppression of the process of phosphorylation in the thymus gland may be due to interaction of the aminothiol with DNA. (JPRS)

41203 UPTAKE OF ^{125}I-LABELED 4-IODOPHENYLALANINE IN TUMORS OF MICE. Blomquist, L.; Flodh, H.; Ullberg, S. (Royal Veterinary Coll., Stockholm). Brit. J. Cancer, 23: 150-2(1969).

A new labeled compound was tested for localization of tumors, some of which were induced in mice with ^{90}Sr. The concentration of this compound in the tumors was studied by whole-body autoradiography. The possible accumulation of 4-iodophenylalanine or related compounds in neoplasms might be of interest for tumor diagnosis by means of external scintillation counting. The ^{125}I-DL-4-iodophenylalanine was synthesized to give a specific activity of 1.89 mCi/mmole (6.5 μCi/mg). Most normal tissues had a lower concentration of 4-iodophenylalanine-^{125}I than the blood. The pancreas showed high uptake. Ehrlich ascites cell tumor had an uptake comparable to that seen in the pancreas. The accumulation was confined to the growing, cellular parts of the tumor where the concentration was about six times higher than the average concentration in the body. A lymphatic leukemic tumor showed a higher concentration of 4-iodophenylalanine than the blood. Within the tumor the weakest radioactivity was seen in the necrotic or hemorrhagic parts. In the growing parts of the tumor the radioactivity was about three times higher than the average radioactivity in the body. A soft fibroblastic osteosarcoma induced by ^{90}Sr had a lower concentration of 4-iodophenylalanine than the blood. The results suggest that iodination in the 4-position of the phenylalanine molecule causes its rejection by the cell membrane transport system in almost all normal tissues except the pancreas but not in certain tumors. This may be of interest in choosing other slightly modified naturally occurring compounds, such as sugars, nucleosides, vitamins, or other amino acids, for selective localization of tumors. (BBB)

41204 BRAIN FUNCTION AND THE SYNTHESIS OF MACROMOLECULES. Armstrong, John Lewis. Seattle, Univ. of Washington, 1968. 206p.

Thesis.

A study was made of the biosynthesis and degradation of macromolecules in the brains of mice and rabbits. The RNA-DNA hybridization technique was applied to the analysis of RNA populations of different regions of the rabbit brain. Comparisons of RNA molecules from the cerebrum, basal region, and cerebellum demonstrated significant regional differences in the proportions of hybridizable RNA molecules of very similar or identical nucleotide sequences. This observation is consistent with other regional differences, such as variation in certain enzyme activities, that have been reported in the literature. A method is described which permits incorporation of ^{3}H or ^{14}C radioisotopes into RNA by an in vitro treatment with dimethyl sulfate. The procedure is rapid and simple and no degradation of the RNA occurs. The hybridization properties of the methylated RNA compare with those of molecules randomly labeled in vivo. The method is of potential value in cases where low metabolic activity or other biological parameters preclude labeling of RNA in vivo. (Disser. Abstr.)

41205 CHANGES IN GLUCOSE BIOKINETICS IN POSTNATAL LAMBS. House, William Albert. Fort Collins, Colo., Colorado State Univ., 1968. 99p.

Thesis.

Glucose pool size, glucose space, glucose entry rate, and extent of glucose oxidation were measured at various times from birth to 1 year of age in five intact male crossbred lambs, using a single-injection isotope dilution technique with glucose-^{14}C. The volumes of several body water compartments were determined using a triple isotope single injection method; ^{125}I-albumin, ^{36}Cl, and T_2O were used to measure plasma volume, extracellular fluid volume, and total body water, respectively. Plasma glucose concentration remained near 100 mg/100 ml during the first two weeks post partum, and then declined. The mean concentration was 80.5, 74.2, and 68.2 mg/100 ml at 56 days, 6 months, and 1 year of age, respectively. Methane production was first detected at the time the glucose concentration began to fall, which suggests that the decline in concentration may be due to development of rumen function. The specific glucose pool size declined 74% between 1 day and 1 year after birth, averaging 527 and 138 mg/kg body weight, respectively. In neonatal lambs the larger specific pool size is due to higher plasma glucose concentration and larger relative volume of extracellular fluid. Data obtained in this study were interpreted as suggesting that during postnatal maturation glucose progressively becomes less important as a metabolite in the energy economy of sheep. (Disser. Abstr.)

41206 EFFECT OF OVARIECTOMY AND REPLACEMENT THERAPY ON RAT ANTERIOR PITUITARY FSH AND NUCLEIC ACIDS. Okia, Nathan Opolot. Indianapolis, Indiana Univ., 1968. 145p.

Thesis.

The effect of ovariectomy on the anterior pituitary nucleic acids and gonadotrophins was studied in young adult female rats. Changes in RNA, DNA, and total protein were followed every day for 5 and 12 days after ovariectomy in two separate experiments. Total gonadotrophins and FSH were followed daily for 7 days. It was found that FSH and total gonadotrophins increase daily from the zero day to day 7 while RNA and total protein decreased with time after ovariectomy. The rate of ^{32}P incorporation into the pituitary was also studied. In castrates, ^{32}P uptake reached a maximum after 1 hour. The ^{32}P incorporation was much higher in normal rats and appeared to reach a peak after 2 hours. The effect of ovariectomy on various species of RNA was further studied by centrifugation on sucrose density gradients. Ovariectomy caused a decrease in ^{32}P uptake into the 4S peak after 4 and 8 hours of incorporation. After 16 hours normal rats showed only slightly more incorporation into all peaks than castrates whereas after 24 hours normal rats showed the highest incorporation in the 28S peak which was higher than a corresponding peak in castrates. Rapidly labelled RNA (t-RNA or m-RNA) was more highly labelled in normal rats than in castrates after an 8½ hour pulse. The 18S peak was the only peak showing the least change as a result of ovariectomy. It was speculated that the step affected by ovariectomy was that involving the conversion of 45S to 28S RNA. Estrogen treatment reversed the effect of ovariectomy on pituitary RNA and protein but appeared to have a depressing effect on DNA. Injection of graded doses of 0.5 – 4.0 μg of estradiol to 5 day castrates for 12 hours did increase ^{32}P uptake into 90% RNA above castrate levels but this was still below the 300% increase in estrus control rats. This indicated that 4 μg of estradiol over 12 hours was below the physiological level of estrogen or perhaps that the castrated animals were less sensitive to exogenous estrogen. The enhancing effect of estrogen over 4 days was about the same whether given as one dose of 5 μg or in single 1 μg daily doses. Estrogen in 1, 2, or 10 μg daily doses for 5 days did not alter the anterior pituitary gonadotropic content of castrates significantly even though it enhanced pituitary RNA content and even though a dose of 1 μg estradiol daily for 5 days into castrates increased the rate of Valine ^{14}C into the gonadotrophic fraction over the oil control. Testosterone at 100 and 200 μg increased pituitary FSH levels with significant change in total gonadotrophins level. At these same doses testosterone showed a slight inhibition of RNA. Progesterone effects mimicked those of testosterone to a lower degree. The rate of pituitary RNA synthesis was similar to gonadotrophic content in that it showed cyclic changes. Pituitary RNA was highest at estrus and metestrus and lowest during diestrus and proestrus. Preformed RNA per pituitary was also highest during estrus but on a mg basis there was little difference between estrus, metestrus, and diestrus, although proestrus RNA content was still low. Preformed RNA was still higher in all stages of the cycle than in 5 day castrates. This indicated that RNA metabolism is abnormal in the castrate animal and also that estrogen may not be the only factor responsible for the content of preformed RNA. Actinomycin treatment at a dose of 70 μg, although lowering pituitary weight, RNA, DNA, and body weight did not lower pituitary gonadotrophins and slightly lowered FSH when given the 2 μg estradiol. With 10 μg estradiol daily for 5 days, 20 μg of actinomycin D synergized with estrogen to lower DNA and FSH. It was suggested that FSH accumulation may cause a depression of RNA synthesis and that estrogen inhibition of DNA synthesis may be the manner by which it controls FSH production. (Disser. Abstr.)

41207 BODY COMPOSITION OF HYPERTHYROID PATIENTS: DETERMINATION BY ISOTOPIC FRACTIONATION. Carlier, B.; Favre, H.; Busset, R.; Jenny, M.; Mach, R. S. (Hopital Cantonal, Geneva). Rev. Fr. Etud. Clin. Biol., 14: 354-60(Apr. 1969). (In French).

Six hyperthyroid patients were studied by an isotopic fractionation technique using ^{42}K, ^{24}Na, ^{82}Br, and tritiated water. The partition of the various fluids was considerably abnormal. The total body water decreased mainly as the result of the decrease in intracellular water. The exchangeable potassium decreased and this was paralleled by the decrease of muscle mass. The extracellular water and the exchangeable sodium were not significantly altered and there was no change in the adipose tissue. It was shown that the weight loss in hyperthyroidism differs from that following a low calorie diet. (auth)

41208 THE ABSORPTION OF ^{89}Sr BY GRAPE VINE UNDER TOP DRESSING. Kavteladze, B. M.; Osei, Yu. P. Soobshch. Akad. Nauk Gruz. SSR, 54: 429-32(May 1969). (In Russian).

The pathways of penetration of radiostrontium into the leaves as well as the effect of radioactive pH solution on the foliar absorption intensity by the grape vine were studied. It has been ascertained that mechanical injury of grape vine foliage favors the penetration of ^{89}Sr into the plant. Comparison of the cuticular and stomatous uptake of ^{89}Sr enables the conclusion that the assimilation of the latter occurs mainly through stomas. Having passed into the stem of the plant by means of the leaf vascular system, radiostrontium moves acropetally, lessening in distribution. The predominant concentration of strontium occurs in the plant leaves. Basipetal translocation of ^{89}Sr is greatly hampered or does not take place at all. In the present case, the higher the acidity of radioactive solution applied to the leaves the more readily it is assimilated and translocated throughout the plant. (auth)

41209 CLINICAL AND EXPERIMENTAL STUDIES ON THE METABOLISM OF ^{131}I–INSULIN. 3. EXPERIMENTAL STUDIES ON THE METABOLISM OF ^{131}I–INSULIN. Yano, Kei (Kyoto Univ.). Naika Hokan, 16: 99-106(Mar. 1969). (In Japanese).

Wistar strain male rats were divided into 16 groups and received various treatments, such as hepatectomy, thyroidectomy, nephrectomy, adrenalectomy or castration, single administration of alloxan or carbon tetrachloride, repeated injections of insulin, ACTH, thyroxine, cortisone, prednisolone, dexamethasone, anabolic steroid, testosterone or estradiol. Thereafter, about 10 μC of ^{131}I-insulin were injected intravenously into normal rats and into various experimental rats, and the fat or the metabolism of ^{131}I-insulin was studied from the ratio of trichloracetic acid-precipitable radioactivities to the trichloracetic acid supernatant radioactivities in the liver, kidney, muscle and blood at 15 minutes after the injection. The speed of metabolism of ^{131}I-insulin was decreased in hepatectomized rats, thyroidectomized rats, nephrectomized rats and in rats treated with insulin, carbon tetrachloride, prednisolone and dexamethasone when compared with that in normal rats. In rats treated with thyroxine, the increased metabolism of ^{131}I-insulin was observed. Adrenalectomy, castration, ACTH, cortisone, alloxan, anabolic steroid and sex hormones gave no significant changes to the speed of metabolism of ^{131}I-insulin in rat tissues. (NSA of Japan)

41210 STUDIES ON THE DISTRIBUTION OF RADIOISOTOPES BY WHOLE-BODY AUTORADIOGRAPHY. 15. DISTRIBUTION OF O-BUTYRYLTHIAMINE DISULFIDE ^{35}S IN ANIMALS. Takahashi, Tadao; Kimura, Tetsuo (Tanabe Seiyaku Co., Saitama, Japan). Bitamin, 39: 236-43(Apr. 1969). (In Japanese).

The distribution of radioactivity has been studied by means of whole body autoradiography in mice, guinea pig, cockerel, young dog and monkey injected intramuscularly with O-butyryl-thiamine disulfide-^{35}S (BuTDS-^{35}S). The distribution of radioactivity in mouse 24 hours after injection of BuTDS-^{35}S was highly accumulated in liver, kidney, myocardium, salivary gland, masseter, gastrointestinal mucosa, brown fat, spinal ganglia, spinal cord and brain. The radioactivity in the lung, pancreas, skin and blood were lower than that in the other organs. The patterns of distribution of the radioactivity in the guinea pig and monkey were similar to that of the mice but the distribution pattern in cockerel was some different from those in other animals. The remarkable accumulation of radioisotope in the liver, kidney, myocardium and gray matter of central nervous system were found for all of animals tested. (NSA of Japan)

41211 STUDIES ON THE INTRALYMPHATIC LOCALIZATION OF RADIOACTIVE MATERIALS. Honda, Takashi (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 80: 70-110(July 1967). (In Japanese).

Selected radioactive preparations were administered to dogs by intralymphatic injection to compare their localization in lymph nodes. This study is applicable to the problem of nodes that contain minute malignant lesions and that are not removed during surgical treatment. According to radioisotopic characteristics, preparations that localize effectively offer a therapeutic approach by selective irradiation and offer diagnostic detection by external scanning or internal probing to guide a surgical treatment. Radioactive preparations were injected into a lymphatic vessel made visible in the hind foot of a dog by a previous interstitial injection of Indirect Sky Blue between the toes. Through an incision in the dorsum of the foot, lymphatic vessels containing the blue dye are clearly seen lying alongside other major vessels. Observations at prescribed intervals include measurements of distribution and excretion, scintigrams by external scanning, and, occasionally, radiography. In general, very small chemical doses (^{90}Y, 10^{-11} $\underline{M}$/kg) prepared from a ^{90}Sr – ^{90}Y generator failed to localize adequately and distribute widely somewhat like intravenous doses. Larger chemical doses (stable yttrium, $10^{-7}\underline{M}$/kg) localized better in lymph nodes; however, animals varied considerably. Results with colloidal ^{198}Au suggested the use of larger particles. By contrast, ceramic microspheres containing ^{144}Ce and suspended in Carbopol localized largely in the first lymph node of the stream. These results show that both particle size and chemical composition influence the distribution and localization of preparations introduced directly into the lymphatic stream. Optimum particle size is probably between 50 mμ and 100 mμ for selective lymph nodal localization. Also, the results suggest that further study of chelates of heavy metals, which act like colloids when administered as dilute ionic solutions, affords a fruitful approach to selective irradiation of lymph nodes, and it would offer a method for the diagnosis of lymphatic system by scanning. (NSA of Japan)

41212 STUDY ON THE PERMEABILITY OF TOOTH TO RADIOISOTOPES. Nakayasu, Akio (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho, 80: 111-38(July 1967). (In Japanese).

The permeability of teeth to radioisotopes ^{131}I and ^{45}Ca was studied on the toothcrown of extracted healthy and carious teeth, grade $C_1 - C_4$. The changes of the permeability after applying a caries-preventive agent, NaF, and a caries-producing agent, citric acid, were examined by scintillation counting as well as autoradiography of sliced teeth. The permeation of ^{131}I and ^{45}Ca through enamel of healthy teeth was not detected. In the decayed teeth, on the other hand, changes of the radioactivity were observed as following: Ratios of ^{131}I in incisor were $C_1 : C_2 : C_3 : C_4 =$ 1.0 : 1.1 : 1.1 : 1.5 : 3.3; in premolar 1.0 : 1.3 : 1.6 : 3.7 : 8.9; and in molar 1.0 : 1.3 : 1.6 : 2.3 : 5.6. That is to say, increase of permeability was low at grade $C_1 - C_2$ and very high at $C_3 - C_4$ in every carious tooth. However, ^{45}Ca did not penetrate as much into the tooth substance in every carious tooth. By submerging specimens in 0.04 to 0.6% NaF solutions, amounts of ^{131}I and ^{45}Ca increased both in healthy and carious teeth in parallel with the concentration of NaF but this increase was proved by autoradiographical findings to be mainly due to adhesion rather than penetration of ^{131}I and ^{45}Ca in tooth substance. By submerging specimens in 3 to 10% citric acid, permeability to ^{131}I increased remarkably both in healthy and carious teeth and a 15 to 20 times increase was observed in C_3 and C_4 compared to the experiment without submerging in citric acid. In ^{45}Ca experiments, increase was observed about 2 times. Thus it was concluded that the results by ^{131}I were chiefly due to the penetration into the tooth substance and those by ^{45}Ca due to chemical reaction. (NSA of Japan)

41213 TISSUE DISTRIBUTION OF ^{212}Bi IN RATS. Hursh, John B.; Brown, Christine (Univ. of Rochester, N. Y.). Proc. Soc. Exp. Biol. Med., 131: 116-20(May 1969).

^{212}Bi, relatively free of its parent ^{212}Pb, was injected intravenously into rats and the tissue distribution was followed for a period of 2 hr postinjection. The kidney contained the highest concentration, equal to about 10 times that of the liver and spleen. A comparison was made of the ^{212}Bi distribution pattern at 2 hr postinjection when ^{212}Bi was introduced free of ^{212}Pb and when injected in transient equilibrium with ^{212}Pb. In the latter case the ^{212}Bi concentration in the red blood cells increased and in the kidney and liver decreased. (auth)

41214 RETENTION OF RADIUM IN MAN. Marshall, J. H.; Rundo, J.; Harrison, G. E. (Argonne National Lab., Ill. Atomic Energy Research Establishment and Medical Research Council, Harwell, Eng.). Radiat. Res., 39: 445-51(Aug. 1969).

While a recent injection of ^{223}Ra was retained as $t^{-0.50}$, a long-term burden of ^{226}Ra in the same man decreased as $t^{-1.7}$. This dramatic difference in the rate of change of retention is predicted by the modified power function model with an observed rate of excretory plasma clearance of 126 liters/day. From the ^{223}Ra data, the model predicts that the ^{226}Ra burden should have reached transient equilibrium within the body (t_y = 6.7 years) so that its retention today can be described by a final exponential. With a somewhat lower average rate of plasma clearance (72 liters/day, t_y = 20 years) the model would be consistent with the retention functions of Norris et al., Miller and Finkel, and the halftime for retention reported by Keane and Evans. Accordingly, it would be most interesting to measure the rates of plasma clearance in the long-term radium cases. (auth)

41215 INFLUENCE OF CULTURE FILTRATES OF SOIL FUNGI ON THE ABSORPTION OF ^{144}Ce AND ^{90}Sr BY EXCISED ROOTS. Zwarun, A. A.; Miller, R. H.; Franklin, R. E. (Ohio State Univ., Columbus). Soil Sci. Soc. Amer., Proc., 33: 632-4(July-Aug. 1969).

Culture filtrates from Aspergillus niger, Aspergillus spp., and two species of Penicillium were studied for their effect on absorption of ^{144}Ce and ^{90}Sr by excised roots of soybean and barley. Filtrates from both species of Aspergillus and one of the Penicilluin markedly decreased the absorption of ^{144}Ce but had little effect on ^{90}Sr. Citric acid was found in the three active filtrates while an unidentified organic acid was found in the other. The reduced absorption of ^{144}Ce could be duplicated by citric acid at concentrations > 10^{-2}M. Kojic, glucuronic, and 2-ketogluconic acids had no effect on absorption of ^{144}Ce, but kojic and 2-ketogluconic acids reduced ^{90}Sr absorption by soybean roots. (auth)

41216 THE INCORPORATION OF INSPIRED ^{14}C IN TISSUES. Warren, Shields; Joftes, David L. (New England Deaconess Hospital, Boston). Radiat. Res., 39: 386-90(Aug. 1969).

Few data exist on the uptake in mammalian tissues of ^{14}C inspired as $^{14}CO_2$. The effects of this uptake are largely a matter of speculation. Mice were exposed for long periods in a special respiratory chamber to concentrations of the radioactive gas ranging from about 20 times below the maximum permissible concentration to over 100 times above. Maximum uptake was obtained after 30 days of exposure. The uptake as measured in disintegrations per minute increased at the highest concentration to over 1000 times background. Histologic study revealed no pathologic effects ascribable either to radiation or transmutation. (auth)

41217 USE OF RADIOISOTOPES IN FOREST RESEARCH. Brown, A. G. At. Energ. Aust., 12: No. 2, 14-17(Apr. 1969).

Various applications of radioisotopes in forestry tracing and measuring are discussed. Reference is made to studies of uptake of ^{32}P by potted Eucalyptus regnans seedlings from the soil, by Eucalyptus marginata seedlings from solution, by small Pinus radiata from stem injection and by Pinus radiata needles from solution. Use of nucleonic equipment in soil moisture determination for water balance studies is discussed, as are methods for non-destructive measurement of leaf water content and the density or thickness of small wood samples. (Australia)

41218 CHANGING NORMAL VALUES FOR THYROIDAL RADIOIODINE UPTAKE. Pittman, James A. Jr.; Dailey III, George E.; Beschi, Richard J. (Veterans Administration Hospital, Birmingham, Ala.). New Engl. J. Med., 280: 1431-4 (June 26, 1969).

Studies of ^{131}I uptake by the thyroid glands of normal persons revealed a general decline in thyroid fixation of radioiodine over the last decade. Determinations of 24-hr thyroid radioiodine uptake were made on 63 euthyroid subjects in 1959 and by the same method on 53 euthyroid subjects in 1967-68. The uptake was 28.6 ± 6.5% in 1959 and 15.4 ± 6.8% in 1967-68 (mean ± S. D.). The low values currently seen reflected a large intake of iodine in the subjects, who displayed elevated urinary iodine excretions, and depressed thyroidal iodide clearances. Food analyses revealed the diet to be very rich in iodine, and bread to be its major contributor to the diet. Further investigation showed that the process used for the commercial manufacture of bread was changed in the interval between the two studies and that the present method includes large quantities of iodine. About half the commercial white pan bread in the United States is now made by this process. (BBB)

41219 EFFECTS OF HYPOPOTASSEMIA ON THE BIOELECTRIC ACTIVITY OF SKELETAL MUSCLES IN THE CHRONIC COR PULMONALE SYNDROME. Grabowski, R.; Matwijewicz, J.; Franecki, G. (Medical Academy, Bialystok, Poland). Pol. Med. J., 8: 312-17(1969).

Translated from Pol. Tyg. Lek., 23: No. 30, 1968.

Studies were performed on the content of ^{42}K in red blood cells using the isotope method and electromyography of the biceps muscle in 20 healthy subjects and in 20 patients with chronic coronary disease during circulatory failure. In patients a significant decrease of potassium content in the red blood cells and decreased mean duration of action potentials of skeletal muscles in relation to the group of healthy controls was found. No clear-cut correlation was observed between the degree of potassium loss from the blood cells and the decreased duration of action potentials in the muscles, although these phenomena appeared parallelly. (auth)

41220 COMPARISON BETWEEN CHICKEN AND GUINEA PIG THYROID WITH RESPECT TO THE INCORPORATION OF ^{131}I IN VITRO. Lague, P. C.; Van Tienhoven, A. (Cornell Univ., Ithaca, N. Y.). Gen. Comp. Endocrinol., 12: 305-12(Apr. 1969).

Differences between chicken and guinea pig thyroids with respect to the metabolism of ^{131}I during in vitro incubation were studied. Phenol red inhibited the ^{131}I uptake by chick thyroid. Chick thyroid took up more ^{131}I during in vitro incubation after Tapazole pretreatment, whereas guinea pig thyroid, which took up less ^{131}I, was not affected by Tapazole pretreatment. Chick thyroid incorporated a higher proportion of ^{131}I into organic fractions than guinea pig thyroid. A possible explanation for this effect is discussed. During in vitro incubation, chick thyroid formed thyroxine plus triiodothyronine and/or diiodothyronine. (BBB)

41221 LOSS OF ^{65}Zn IN THE MUSSEL MYTILUS GALLOPROVINCIALIS. Keckes, Stjepan; Ozretic, Bartolo; Krajnovic, Mirjana (Institut Rudjer Boskovic, Zagreb). Malacologia, 7: 1-6(Dec. 1968).

Because of the increasing importance of ^{65}Zn in marine ecology, its uptake and loss from hard and soft tissues of Mytilus were studied. Results showed that the soft tissues of Mytilus bind ^{65}Zn more firmly than the shell and that the time during which the mussels were in contact with ^{65}Zn had a considerable influence on its loss. The loss of ^{65}Zn (expressed as percentage of the ^{65}Zn content of the animals at the beginning of the loss experiment) was significantly lower both in the soft tissues and shells when the animals had been in contact with ^{65}Zn for a longer period. Thus, on the 7th day of the loss experiment, only about 3% of the initial activity was lost from the soft tissues of mussels which had previously been in contact with ^{65}Zn for 21 days, while about 35% of the initial radioactivity was lost from those which had had contact with ^{65}Zn for only 24 hr. This difference was even more evident for values obtained for the shell (8% against 70%). The total amount of ^{65}Zn lost from the animals in 7 days was approximately the same and did not depend on the duration of exposure to ^{65}Zn. That the overall loss rate was not constant in a semilogarithmic system indicated more than one mechanism of Zn loss. In general, the first part of the loss curves was much steeper than those following. Addition of EDTA (ethylenediaminetetraacetic acid) accelerated the removal of the isotope from the mussels. (BBB)

41222 RUBIDIUM UPTAKE AND EXCHANGE OF ROOTS INFLUENCED BY LOW TEMPERATURE AND SOME INHIBITORS. Zsoldos, F.; Sirokman, F.; Cseh, Edith (Josef A. Univ., Szeged). Z. Pflanzenphysiol., 60: 169-71(Feb. 1969).

The exchange of ^{86}Rb and K was studied at different temperatures in excised roots of rice and sorghum. Roots of 8-day-old rice seedlings and of 5-day-old sorghum seedlings were from plants grown in a 10^{-4}M solution of $CaSO_4$. Before the absorption period they were kept in distilled water for 15 to 20 min. The absorption solution was 5×10^{-4}M ^{86}RbCl and pH value ranged between 5.5 and 6. For the experiments with inhibitors, absorption solutions of 5×10^{-4}M ^{86}RbCl containing 5×10^{-5}M of 2,4-dinitrophenol (DNP), 10^{-4}M of KCN, or 5×10^{-5}M of NaF were used. In short-term experiments a considerable part (about 50%) of the absorbed ^{86}Rb was exchanged with K ions under the effect of cold shock at 1.5°C. This process was significantly slower at 8°C, where there is no shock effect, than at 1.5°C, and at 20°C it slowed still more. The addition of DNP to the absorption solution of RbCl did not appreciably influence the ion uptake of the Rb ions of excised roots of sorghum at cold shock effect temperature. Consequently, under this condition the ^{86}Rb ion uptake is independent of metabolic activity. (BBB)

41223 RETENTION OF COBALT IN EXPERIMENTALLY INDUCED KIDNEY DISEASE. STUDIES OF ^{60}Co IN IRRADIATED AND SUBLIMATE-POISONED MOUSE KIDNEY. Salmi, Heikki A.; Lindgren, Ilmari (Univ., Turku, Finland). Acta Radiol., Ther., Phys., Biol., 8: 208-14(June 1969).

The accumulation of ^{60}Co in experimentally damaged mouse kidney, was studied by means of autoradiography and scintillometry, the damage being induced either by corrosive sublimate poisoning or by open roentgen irradiation. The radioactivity accumulated in the tubular cells of the cortex both in the diseased and healthy kidneys. The role of cobalt in renal anemia and the production of erythropoietin are discussed. (auth)

41224 LABELLED COMPOUND RELATED TO SYNKAVIT AND ITS UPTAKE IN CERTAIN HUMAN TUMOURS STUDIED BY RADIO-ISOTOPE SCANNING. Marrian, D. H.; Mitchell, J. S.; Bull, C. H.; King, E. A.; Szaz, K. F. (Cambridge Univ., Eng. Addenbrooke's Hospital, Cambridge, Eng.). Acta Radiol., Ther., Phys., Biol., 8: 221-46(June 1969).

An account is given of the method of preparation of the labelled compound 6-^{131}I-iodo-2-methyl-1,4-naphthaquinol bis (di-ammonium phosphate) (abbreviated 6-^{131}I-iodo-MNDP) and of investigations carried out so far to study its uptake in certain advanced human malignant tumors and in some experimental tumors in rats and mice. Supplementary evidence with tritiated MNDP is considered. (auth)

41225 DISTRIBUTION AND EXCRETION OF RADIOIRON IN THE RAT AS INFLUENCED BY CHELATING AGENTS. Guenther, Rolf (Kernforschungszentrum, Karlsruhe, Ger.). Arch. Pharmol. Exp. Pathol., 262: 405-18(1969). (In German).

The influence of various chelating agents on the distribution and excretion of radioiron, carrier-free or diluted with stable carrier, was studied in rats. Simultaneous administration of chelating agents lowers the retention of radioactive iron in all tissues whereas after delayed treatment a small fraction of storage iron can be removed from liver and spleen. The efficacy is higher in the case of isotopically diluted radioactive iron. The most effective compounds are ethylenedi(α-o-hydroxyphenyl)glycine, 2-(β-aminoethoxy)cyclohexylaminetetraacetate, and desferrioxamine B. The practical value of the former chelator, however, is excluded by its high toxicity. (auth)

41226 CHANGES OF RESISTANCE AGAINST X-RAYS INDUCED BY CONTINUOUS ADMINISTRATION OF ^{137}Cs AND ^{90}Sr IN MICE. Megumi, Tsuneo; Yonezawa, Morio; Nishio, Kazuo. Annu. Rep. Radiat. Center Osaka Prefect., 9: 94-7(1968).

Resistance of mice continuously fed with water containing ^{137}Cs and ^{90}Sr was determined at ages of 7 to 11 weeks. Mice of NA-2 strain were divided into four groups. Group I was fed with 0.4 μCi of ^{137}Cs and 0.1 μCi of ^{90}Sr per ml, group II with 0.04 μCi of ^{137}Cs and 0.01 μCi of ^{90}Sr, group III with 0.004 μCi of ^{137}Cs and 0.001 μCi of Sr, and group (control) with tap water. X-irradiation was given in doses of 600 to 900 R, and X ray resistance was expressed by the survival ratio 30 days later. Group III was most resistant to doses of 700 and 800 R; females were more resistant than males. Males showed better resistance against doses of 600 R. Group II showed less resistance than III. None of the mice were resistant to doses of 900 R. Group III showed considerable resistance to 900 R given in two split doses of 450 R each. (auth) (TSS)

41227 EFFECTS OF ^{137}Cs AND ^{90}Sr ADMINISTERED CONTINUOUSLY AND THROUGH GENERATIONS UPON MICE. VI. Nishio, Kazuo; Megumi, Tsuneo; Yonezawa, Morio. Annu. Rep. Radiat. Center Osaka Prefect., 9: 86-93(1968).

Effects of ^{137}Cs and ^{90}Sr were studied in respect to growth, reproduction, life span, and x ray tolerance in mice of NA-2 strain continuously given these isotopes through ten generations. The tabulated results show that the effects varied with doses administered. (auth) (TSS)

Radiation Effects

Refer also to abstracts 40684, 41456, and 41467.

41228 (AD-681340) EFFECT OF X IRRADIATION (0.6 TO 2.4 kR) ON CATION ACTIVATED ATPases FROM SUBCELLULAR FRACTIONS OF RAT BRAIN. Cummins, Joseph T.; Vaughan, Burton E. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 12, 1968. 19p. (USNRDL-TR-68-128). CFSTI.

A small significant increase in the activity of a purified ATPase stimulated by Na(+) + K(+) was demonstrated following x irradiation at doses of 0.6 to 2.4 kR. Regression analysis indicates a curvilinear radiation effect, with a significant plateau at doses above 1.2 kR. After 1200 R, a decrease of this same enzyme activity was noted when the more reactive sylfhydryl groups were blocked with n-ethylmaleimide. Only the activity stimulated by Na(+) + K(+) was significantly affected by irradiation. Further fractionation of the enzyme complex indicated that a lipid band in the Ficoll gradient isolation was sensitive to 1200 R. Although this effect was not noted in vivo, it was considered that much of the enzyme could be rapidly repaired in vivo. Radiation damage to such constituents of a membrane system would explain many neurological radiation effects. (auth) (TAB)

41229 (NYO-2085-13) STUDIES ON BIOLOGICALLY ACTIVE AMINES. Annual Progress Report, June 15, 1968–June 15, 1969. Kobayashi, Yutaka; Maudsley, David V. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Contract AT(30-1)-2085. 9p. Dep. CFSTI.

The effects of x radiation on the activity of histidine decarboxylase (HD) were studied in starved rats. The results indicated that 2000 R x irradiation 24 hr prior to starving reduced the HD activity in the rats. Forced feeding was ineffective in restoring HD activity, but insulin resulted in a significant rise in activity. In vitro studies of brocresine (ND-1055) indicate that the drug is a potent inhibitor of HD. In vivo studies using freely fed rats indicated only a transient drop in HD activity of about 40%, recovery of activity occurring within a few hours. On administration to starved rats, ND-1055 reduced HD activity, and when given at the same time as HD stimulators (insulin, pentagastrin, food), the usual increase in HD is markedly reduced. NSD-1005 also inhibited diamine oxidase activity. An isotopic method using ^{3}H-S-adenosylmethionine was developed that has a sensitivity for histamine of 0.5 nanograms. Three computer programs were developed to facilitate the computation of data from liquid scintillation counter data. A list of published articles, articles in press, and articles submitted is included in the report. (E.R.B.)

41230 (TID-25133) PHYSICAL MECHANISMS IN THE INACTIVATION OF PROTEINS BY RADIATION. (Michigan State Univ., East Lansing). [1969]. Contract AT(11-1)-1155. 17p. Dep. CFSTI.

The goal of this program is to understand the molecular processes in proteins that are initiated by radiation and result in inactivation. This objective is being pursued by carrying out biochemical and solid-state studies on enzymes irradiated in solutions and in dry preparations. Much of the work has involved a comparison of the effects of uv and ionizing radiation on such systems. The basis for this work is the hypothesis that inactivation occurs when a sufficient amount of the absorbed energy becomes localized in a cluster of disulfide and hydrogen bonds that are crucial to the maintenance of the unique topography of the active site. Using 2537 A light the involvement of cystine and hydrogen bonds in the inactivation procedure was shown. However, such a wavelength was chosen as the most favorable to show this effect. Thus, it is now important to compare these results with the effects observed at other wavelengths and with ionizing radiation. The basic hypothesis above would predict that molecular rearrangements that are initiated by ionizing radiation essentially at random within the molecule become localized at only a restricted number of sites. Evidence consistent with this notion was provided by studies of the thermoluminescence from proteins and amino acids. The following results were obtained during 1968 in the different aspects of this project. There was found a correlation between uv-radioinduced inactivation of RNAase and the disruption of cystine. The only amino acid destroyed when RNAase was irradiated at 229 to 280 nm was cystine. In addition to these results, it was found that uv irradiation opened the RNAase molecule so that two or all three of the remaining disulfides were susceptible to reduction by mercaptoethanol. Lability studies indicated that inactivation of the macromolecule involved the irreversible splitting of a cystine with consequent loss of the conformation essential to enzyme activity. Phosphate binding, on the other hand, was not affected. In thermoluminescence studies of the effects of the microenvironment on emission by amino acids, peptides and proteins, it was found that for tryptophan, there was a marked dependence upon solvent and temperature for transition to occur. In the case of the peptide tryptophyl-tyrosine, emission was typical of that for tryptophan alone indicating that either tyrosine emission was quenched or else there was energy transfer from the tyrosine to the tryptophan. Comparison of emission patterns from the protein hyaluronidase with those of trypsin indicated that in both cases emission was greatly affected by changes in the external environment. Efforts to determine the effects of slow electrons of a given incident energy on enzymic damage were impeded by background scattering effects on accurate dosimetry calculations. There is reason to believe that recent efforts to correct this have been successful. (E.R.B.)

41231 (TID-25162) REACTIONS BETWEEN ELECTRONS AND BIOLOGICAL SUBSTANCES. Final Report. Zlatkis, Albert (Houston Univ., Tex. Dept. of Chemistry). June 1969. Contract AT(40-1)-3541. 8p. Dep. CFSTI.

A number of areas relating to the overall problem of the reactions between electrons and biological substances were investigated. The following is a brief summary of the progress made. New instrumentation was developed for studying compounds that have a large cross section for electron absorption. A ^{63}Ni detector has proven extremely sensitive and capable of operation to 400°C. A corona discharge cell was designed for reacting organic compounds with electrons at thermal energy. Several compounds were reacted using this cell and the products analyzed by gas chromatography-mass spectrometry. Dissociative or non-dissociative mechanisms can be interpreted from this information. A number of derivatives that are potentially useful in electron absorption studies were prepared. These can be applied to compounds of biological interest by making them detectable in trace quantities, e.g., steroids. The possible use of the electron capture technique as a means of spectroscopy was also initiated. The results indicate that applications may be possible in analytical gas chromatography. (auth)

41232 (UCLA-12-737) STUDIES ON THE CHEMICAL BASIS OF CELLULAR RADIOSENSITIZATION BY 5-BROMOURACIL SUBSTITUTION IN DNA. II. PULSE AND STEADY STATE RADIOLYSIS OF REGULAR AND BROMOURACIL-SUBSTITUTED DNA. Zimbrick, J. D.; Ward, J. F.; Myers, L. S. Jr. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT-04-1-GEN-12. 20p. Dep. CFSTI.

Pulse and steady-state radiolysis studies show two major differences in the radiation chemistry of aqueous solutions E. coli DNA (reg-DNA) and bromouracil substituted DNA (BU-DNA): on exposure of N_2-saturated solutions to low doses of radiation the absorbance of BU-DNA increases while that of reg-DNA decreases; the free radicals formed by OH· attack on BU-DNA decay more rapidly than those on reg-DNA. The differences are explained by a mechanism involving conversion of the BU moiety of BU-DNA to a uracil (U) moiety by reaction of BU-DNA with organic free radicals. Uracil-5-yl radicals are formed which may abstract H· from neighbouring deoxyribose moieties to give uracil and a radical which may lead to a single strand break. A hypothesis for BU radiosensitization, based on these and earlier results, accounts for more DNA base damage and more single strand breaks in BU-DNA than in reg-DNA; and formation of U in BU-DNA. (auth)

41233 THE RBE OF ^{137}Cs γ, 250 kV AND 100 kV X-RAYS FOR MITOTIC DELAY AND SURVIVAL IN HUMAN KIDNEY CELLS. Scaife, J. R. (EURATOM, Ispra, Italy). Int. J. Radiat. Biol., 15: 279-83(1969).

Techniques are described for collecting human kidney T cells and producing mitotic synchrony. Cells were irradiated with 100 and 250 kV x rays at a dose rate of 50 R per min and with ^{137}Cs γ rays at a dose rate of 110 R per min. Survival curves are presented for cells irradiated in glass flasks and in plastic petri dishes. The RBE values were calculated from ratios of doses at a point on the exponential part of the curves. The RBE for γ radiation was 0.87 relative to x radiation when cells were in glass. For cells irradiated on plastic the RBE was 0.93 for γ radiation in comparison with x radiation. Experiments on the effects of radiation on mitotic delay showed that the RBE was 0.46 for γ rays and 1.21 for x rays on glass; corresponding values for plastic were 0.48 and 1.15. (H.L.W.)

41234 MACROMOLECULAR SYNTHESIS AND THE EXTENT OF IONIZING RADIATION-INDUCED DNA DEGRADATION IN BACTERIA. Grady, Leo Joseph. University Park, Pa., Pennsylvania State Univ., 1968. 99p.

Thesis.

The initial aim of this study was to determine if a correlation existed between cellular capacity to synthesize macromolecules and the extent of deoxyribonucleic acid (DNA) degradation in bacteria which had been exposed to ionizing radiation. Toward this end, postirradiation DNA breakdown was examined under the following conditions: steady state growth in media supporting different rates of growth; during transition states when cells are adapting from conditions in one medium to those in another; in the presence of chloramphenicol, proflavine, or actinomycin D; following preirradiation starvation of a thymine and uracil requiring bacterium for one or both of these bases. As a result of such experiments, a role was established for messenger RNA and subsequent protein synthesis in modifying the extent of DNA degradation. The nature of the alterations in degradation associated with these synthetic processes was such that induction of the defective prophage known to be carried by the bacteria used was implicated in stopping the degradation reaction. Accordingly, additional experiments were then carried out comparing DNA degradation in a strain of bacteria cured of prophage and the parent from which it was derived. In all cases, the results were consistent with the idea that some step in prophage induction served to inhibit the degradation process. A correlation, under one set of conditions, was also demonstrated between the presence of the defective prophage and increased colony forming ability after irradiation. The overall results led to the hypothesis that the presence of a defective prophage can result in less degradation than would otherwise be observed and may also be responsible for increased survival under certain conditions. (Disser. Abstr.)

41235 EFFECT OF PROTEIN AND AMINO ACID NUTRITION ON RADIATION DAMAGE IN MICE. 3. EFFECT OF AMINO ACID COMPOSITION ON HAEMATOPOIETIC ACTIVITY AFTER IRRADIATION. Tanaka, Seiei (Tokyo Metropolitan Isotope Research Center). Eiyo To Shokuryo, 22: 193-7(Apr. 1969). (In Japanese).

The effect of protein quality (amino acid composition) on the hematopoietic activity of mice after whole-body irradiation was studied. Groups of mice were fed on the diets free of one of the following amino acids: valine, lysine, tryptophane, leucine · isoleucine, methionine, or histidine. Haematopoietic activity was determined by the incorporation of ^{59}Fe into blood. Deficiencies of one valine, leucine · isoleucine, tryptophane, or histidine showed great effect, and those of lysine or methionine little effect upon the haematopoietic activity after irradiation. The omission of these four amino acids in the diets considerably delayed the recovery of the activity. (NSA of Japan)

41236 EFFECT OF PROTEIN AND AMINO ACID NUTRITION ON RADIATION DAMAGE IN MICE. 2. EFFECT OF PROTEIN AND AMINO ACID NUTRITION ON ^{59}Fe-INCORPORATION INTO HAEMATOPOIETIC ORGANS OF IRRADIATED MICE. Tanaka, Seiei (Tokyo Metropolitan Isotope Research Center). Eiyo To Shokuryo, 22: 188-92(Apr. 1969). (In Japanese).

The preceding papers revealed that the mortality of single dose, whole-body γ-irradiated mice was greatly reduced by the supplement of protein in diets before and after irradiation. In the present paper, the effect of dietary protein reinforcement after γ irradiation on the incorporation of ^{59}Fe into mice blood is reported. From the results of the experiments, it was shown that the ^{59}Fe incorporation into blood was influenced by the dietary protein nutrition before and after irradiation, and that protein nutrition in the recovery stage from hematopoietic radiation damage was very important. These findings were in accordance with the results of the mortality experiments reported previously. (NSA of Japan)

41237 DNA CYTOPHOTOMETRY OF RADIATION-INDUCED MOUSE THYMOMA. Adams, Lawrence R.; Lagerloef, Bengt (Karolinska Sjukhuset, Stockholm). Acta Cytol., 13: 122-7 (Mar. 1969).

In order to characterize the early alterations occurring during the thymoma development, per-cell DNA-content distributions in populations of thymus cells were determined cytophotometrically at various intervals following leukemogenic radiation. C57Bl mice, 5 weeks old, were subjected to 680 rad of unfiltered ^{60}Co irradiation in 4 equal doses separated by 7-day intervals. Some animals designated as thigh-shielded were irradiated with the hind legs outside the beam. Animals were sacrificed at about 40, 65, and 100 days. Thymus cell populations from untreated mice had uniform DNA content and exhibited a sharp diploid peak in DNA histograms. Regenerating thymus cells from mice exposed to thigh-shielded irradiation, which prevented tumor development, showed slightly increased DNA synthesis, as did thymus cells from mice exposed to leukemogenic radiation but which failed to develop tumors. In radiation-induced thymomas at early stage of development there were signs of more marked proliferative activity but no indication of aneuploidy. Disseminated thymomas harvested at the terminal stage of the disease showed strong proliferative activity. In 1 lowly differentiated lymphoma there was gross ploidy change, and in 2 more cases slight indication of aneuploidy was seen. These may represent new stem lines. (BBB)

41238 INTERFERON SYNTHESIS IN X-IRRADIATED ANIMALS. III. THE HIGH RADIOSENSITIVITY OF MYXOVIRUS-INDUCED CIRCULATING INTERFERON PRODUCTION. De Maeyer, Edward; De Maeyer-Guignard, Jacqueline; Jullien, Pierre (Institut du Radium-Biologie, Orsay, France). Proc. Soc. Exp. Biol. Med., 131: 36-41(May 1969).

The effect of x irradiation on circulating interferon induction was examined in C_3H/He mice, 4 days after total-body exposure to 125, 250, 500, or 1000 R. Nine viruses were tested as inducer: Newcastle disease, influenza A, Sendai, mumps, Sindbis, Semliki Forest, vesicular stomatitis, encephalomyocarditis, and vaccinia. Interferon induction by the four myxoviruses was very radiosensitive, exposure to 125 R being sufficient to reduce serum interferon levels to values ranging between 4 and 28% of levels in control animals. In contrast, interferon induction by either encephalomyocarditis or vaccinia viruses was very radioresistant, and even after 1000 R significant amounts of circulating interferon were produced. Circulating interferon induction by vesicular stomatitis, Sindbis and Semliki Forest was of intermediate radiosensitivity. The high radiosensitivity of myxovirus-induced circulating interferon production suggests an involvement of lymphocytes in circulating interferon induction by these viruses. (auth)

41239 ELECTROLYTE DISTRIBUTION SPACES IN ABDOMEN-IRRADIATED RATS. Bouckaert, A. (Univ. Louvain, Belgium); Cantraine, F. Atomkernenergie, 14: 223-5(July.-Aug. (1969).

Sodium and bromide dilution spaces, exchangeable sodium and potassium pools, and plasma volume were measured in rats following lethal X irradiation of the abdomen. The pattern of modifications observed supports the hypothesis of a primary role played by gastric permeability changes in the pathogenesis of the gastrointestinal radiation syndrome. (auth)

41240 EFFECT OF β-RAYS ON DNA SYNTHESIS DURING CORNEAL WOUND HEALING. Hanna, Calvin; Combs, Stanley W.; Barnhard, Howard J. (Univ. of Arkansas, Little Rock). Amer. J. Ophthalmol., 68: 291-5(Aug. 1969).

Nonpenetrating wounds were made across the center of the rabbit cornea. Two hours before removing the eyes an intercameral injection of ^{3}HTdR was made to detect those cells undergoing DNA synthesis. A ^{90}Sr source of β-rays was applied to the corneas prior to (30, 7 and 3 days) or after (1 to 4 days) wounding. When the injury was made after the administration of 930-3,720 rad of β-rays there was a dose-related decrease in the number of cells undergoing DNA synthesis with a marked effect on the rate of DNA synthesis per cell, but no change in the number of blast-like cells appearing at the wound edge. These results appear to indicate that the radiation-induced delay in wound healing of the cornea is principally due to an inhibition of keratocyte transformation into keratoblasts. Finally, this study suggests that, during wound healing of the cornea, the keratoblasts appearing at the wound edge result from transformation to blastlike cells and from migration of adjacent keratocytes to the wound edge. (auth)

41241 MIGRATION OF RADIATION DAMAGE IN DNA. Singh, B. B. (Bhabha Atomic Research Centre, Bombay). Advan. Biol. Med. Phys., 12: 245-51(1968).

Nucleoproteins (sperm heads), DNA, and several complexes were irradiated with cobalt-60 γ and ultraviolet radiations and their ESR lines were measured. DNA gave a single symmetrical ESR line on irradiation and observation at 77°K. When the individual bases of DNA were irradiated, similar signals were obtained in adenine and guanine, but not in cytosine and thymine. When warmed to room temperature, the signals decayed; in the case of DNA a radical formed. The nucleoprotein gave a single symmetrical ESR signal similar to that of DNA, which reacted to warming in the same manner as DNA. It is suggested that the close similarity between the ESR spectra of DNA, adenine, and guanine suggest that the unpaired electron was localized on one of the purine bases. The difficulties involved in this postulation are discussed. The radiobiological significance of the findings are also considered. (C.O.)

41242 MAMMALIAN CELL DNA ISOLATED WITH MINIMAL SHEARING A SENSITIVE SYSTEM FOR DETECTING STRAND BREAKS BY RADIATION. Terasima, Toyozo; Tsuboi, Atsushi (National Inst. of Radiological Sciences, Chiba, Japan). Biochim. Biophys. Acta, 174: 309-14(Jan. 21, 1969).

Long strands of mammalian DNA were obtained through a deproteinization procedure giving a minimum amount of shearing of the DNA. The sedimentation profile of molecules obtained from irradiated cells was examined for evidence of strand breaks. Irradiation with x rays and DNA isolation was carried out on L$_5$ cells, a hypotriploid derivative of the mouse L strain (B$_{82}$–L$_7$J). The sedimentation patterns in neutral and alkaline sucrose gradients after centrifugation for 45 min at 20° showed that 65 to 85% of the radioactivity from incorporated ^{3}H-thymidine was found in 3 fractions (10% of total volume) which were distinctly characterized by higher viscosity than other fractions. Most of the radioactivity in the alkaline sucrose gradient sedimented at a higher rate than those in the neutral medium, suggesting a conversion of double helices of DNA into denatured single strands. Sedimentation profiles in the neutral sucrose gradient of ^{3}H activity recovered from cells irradiated with 2.8 and 7.5 krad showed that as the dose increased, the profile shifted toward the meniscus. A slight broadening occurred in the profiles. For 9.4 krad, the widening of the profile was more extensive so that a single peak occurred which included about 13 fractions. The sedimentation constant of DNA molecules broken into a half length was estimated to be 79% of the value of intact molecules. The dose needed for breaking a double-stranded DNA in half was ~7.5 krad. The dose needed for halving the molecular weight of native DNA (9×10^8 dalton) seemed to be more than 400 krad. Therefore, the use of long strands of DNA is a sensitive system in detecting double-strand scissions by radiation. Assuming a molecular weight of 2×10^{10} dalton for the DNA of L$_5$ cells, the nucleus of the cell should contain about 450 molecules. Since each molecule will have one break, on the average, after an exposure to 7.5 krad, about 17 rad would be necessary to cause one break per nucleus. Thus, it may be that about 10 breaks of double-stranded DNA are needed for the death of L$_5$ cells whose mean lethal dose was determined to be ~175 rad. (BBB)

41243 ON THE X-RAY-INDUCED THERMOLUMINESCENCE OF SOME PROTEINS IN THE DRY STATE AND IN SOLUTION. Nummedal, D.; Steen, H. B. (Norwegian Radium Hospital, Oslo). Radiat. Res., 39: 241-51(Aug. 1969).

Thermoluminescence (TL) glow curves have been obtained for trypsin, trypsinogen, ribonuclease, and tryptophan irradiated with x-rays at 77°K in the form of dry films as well as in ethyleneglycol/H_2O glass. Except for ribonuclease and dry tryptophan which exhibited relatively weak TL, the spectra of the TL were recorded and compared to those observed during irradiation. It was found that the spectra of the TL of trypsin and trypsinogen both in the dry state and in glassy solution closely resembled the tryptophan-like part of their phosphorescence spectra, while no TL within the fluorescence band could be observed. There appeared to be no contribution to the TL from residues other than tryptophan. A comparison of the results obtained with trypsin and trypsinogen as well as with trypsin denatured by heat treatment indicated that the TL of these proteins was not critically dependent upon their tertiary or secondary structure. (auth)

41244 EFFECT OF X-IRRADIATION ON POLYRIBOSOME ORGANIZATION AND RNA LABELING IN THE LIVER OF NORMAL AND ADRENALECTOMIZED RATS. Cammarano, Piero; Pons, Susetta; Chinali, Gianni; Gaetani, Sancia (CNEN-CSN, Rome). Radiat. Res., 39: 289-304(Aug. 1969).

Exposure of rats to a single whole-body-dose of x-rays (550 or 850 rads) leads to an increased formation of liver polyribosomes at the expense of monosomes and smaller oligomers. The effect of irradiation on the polysome organization of rat liver is observed in both normal and adrenalectomized animals and is accompanied by an enhanced incorporation of ^{14}C-orotic acid into the liver cytoplasmic RNA; 40 minutes after isotope injection the specific activity of the smaller native ribosomal subunit is 2.0 to 2.5 times as high as normal. It is postulated that an excess output of native subribosomal particles, carrying peptide chain initiators, is the factor responsible for the increased polysome formation in the liver of x-irradiated rats. (auth)

41245 CHEMICAL PROTECTION AGAINST SINGLE-STRAND BREAKS IN DNA OF GAMMA-IRRADIATED E. COLI. Ginsberg, D. M.; Webster, H. K. (Walter Reed Army Medical Center, Washington, D. C.). Radiat. Res., 39: 421-35(Aug. 1969).

The effects of a chemical radioprotectant, beta-mercaptoethylamine (MEA), on gamma-induced single-strand breaks in DNA from three strains (B/r, B$_{s-1}$, and 15TAU-bar) of Escherichia coli were studied. The amount of DNA single-strand breakage in irradiated cultures was similar in all three strains. Although MEA enhanced radiation survival in both logarithmic- and stationary-phase cultures, it protected against DNA strand breakage only in the stationary-phase cultures. Single-strand breakage of DNA could not be correlated with radiation killing, even in the very radiosensitive strain B$_{s-1}$. The effects of MEA on DNA strand breakage and killing in cultures of strain 15TAU-bar starved of amino acids with and without methionine provided further evidence that single-strand breaks in DNA are not significant lesions in gamma-ray killing of bacteria. (auth)

41246 KINETICS OF UNSCHEDULED DNA SYNTHESIS INDUCED BY IONIZING RADIATION IN HUMAN LYMPHOCYTES. Spiegler, P.; Norman, A. (Univ. of California, Los Angeles). Radiat. Res., 39: 400-12(Aug. 1969).

A study of the rates of incorporation of ^{3}H-thymidine (^{3}HTdR) and ^{3}H-deoxycytydine (^{3}HCdR) into the DNA of human lymphocytes following exposure to ionizing radiation suggests the presence of two processes: One is rapid, essentially completed within an hour after irradiation; the other is slow and persists for at least 7 hours after irradiation. The rapid process can be adequately represented by a simple enzyme model for which the substrates are ^{3}HTdR or ^{3}HCdR and the radiation-induced lesions in the DNA. In terms of the model, the effect of anoxia is to decrease two-fold the concentration of lesions. The action of phytohemagglutin is to double the concentration of enzyme prior to the onset of normal DNA synthesis. The slow process can also be represented by a simple enzyme model with radiation-induced lesions as substrate. (auth)

41247 EFFECTS OF THE X IRRADIATION IN VITRO ON THE O_2 UPTAKE AND ON THE UTILIZATION OF GLUCOSE BY

THE INTESTINE. Jordana, R.; Ponz, F. (Univ. of Navarra, Pamplona, Spain). Rev. Espan. Fisiol., 25: 129-36(June 1969).

The effects of exposure in vitro of strips of rat jejunum to x irradiation on the O_2 uptake, utilization of glucose, and production of lactate are reported. The dose of the irradiation was 20,000 R (1000 R/min). The irradiated strips always had O_2 uptake values lower than the controls; the difference was more evident in the course of time. From the third or fourth hour onward, the tissue respiration actually stopped. The inhibition in the first hr reached 29% and in the fifth hr 88%. The total amount of lactate produced after 1, 3, and 5 hr of incubation was the same with and without irradiation. The O_2 uptake in the control strips was higher after inclusion of glucose in the medium. Irradiation, as in a medium free of glucose, produced a strong inhibition of O_2 uptake. The inhibition was about 23% in the first hr and reached 75% in the fifth hr. Irradiation clearly inhibited the utilization of glucose, the effect being observed even in the first hour. After 3 hr, the irradiated tissue was no longer capable of metabolizing the glucose still remaining in the medium. (BBB)

41248 FAT METABOLISM IN γ-IRRADIATED GROUNDNUT IN RELATION TO OTHER METABOLIC PRODUCTS. PART I. Patel, G. M.; Patel, K. C.; Patel, R. D. (Sardar Patel Univ., Vallabh Vidyanagar, India). Fette-Seifen-Anstrichm., 71: 303-8(1969).

The peanut variety AK-12/24 MP (Arachis hypogaea) was exposed to ^{60}Co γ rays at dose levels of 10, 30, 50, 70, 90, and 120 kR. Control and irradiated seeds were germinated for 0, 1, 3, 6, 12, 20, and 30 days. Oil fractions from cotyledons of germinating seeds were assayed. Irradiation of the seeds had little effect on their neutral oil content during the initial period of germination, during which the free fatty acids and carbohydrates supply the energy of respiration. Free fatty acids do not accumulate throughout germination. Irradiation affected the rate of utilization of neutral oil, active metabolism of which occurs after the 6th day in the control seeds and seeds exposed to 10 to 50 kR. Interconversion of fatty acids occurs from the beginning of germination, whereby the amount of linoleic acid in groundnut increases during the early stage. Linoleic acid initiated the metabolism, indicating the preferential mode of fatty acid utilization. It is suggested that mitochondrial processes involved in interconversion of fatty acids are inhibited in seeds exposed to high dose levels, indicating severe damage to the nuclei and cells of the seedlings. Thus, the rate of fatty acid utilization is poor in these seeds on germination. (BBB)

41249 RADIATION-INDUCED RELEASE OF CATECHOLAMINES FROM PERFUSED BOVINE ADRENAL GLAND. Deanovic, Zivan; Veninga, Tjeerd S. (State Univ., Groningen, Netherlands). Acta Radiol., Ther., Phys., Biol., 8: 215-20(June 1969).

Isolated bovine adrenal glands were perfused through the central adrenal vein and irradiated with 1000 R. The catecholamine content in aliquots of the perfusate after irradiation presented a gradually increasing trend, in contrast to the decrease observed in sham-irradiated controls. A significant difference in the release rate of catecholamines existed between the two groups. The findings are discussed in relation to the possible role of catecholamines in the early neuro-endocrine reactions to irradiation. (auth)

41250 EFFECTS OF WHOLE-BODY X-IRRADIATION ON THE INCORPORATION OF ^{3}H-OROTIC ACID INTO NUCLEAR RNA FRACTIONS OF RAT LIVER. Omata, Saburo (National Inst. of Radiological Sciences, Chiba, Japan); Ichii, Shogo; Yago, Nagasumi; Kobayashi, Shigeru. J. Radiat. Res., 10: 17-24(Mar. 1969).

Rate of the incorporation of ^{3}H-orotic acid into two rapidly labelled RNA fractions, pH 7.6 RNA and pH 8.3 RNA fractions, of liver nuclei was examined in rats given whole-body x-irradiation of 650 R. The rate of the incorporation showed an increase immediately after irradiation, and a decrease during the succeeding four days, and then returned to the control levels. Degree of decrease in the incorporation by x-irradiation was greater in the pH 7.6 RNA fraction than in the pH 8.3 RNA fraction. Sucrose density gradient analysis revealed that there was a minor modification of sedimentation profile of pH 7.6 RNA while no change was detected in pH 8.3 RNA, at one day after x-irradiation. The incorporation of ^{3}H-orotic acid into the acid-soluble fraction of whole liver cells did not change significantly. Free pyrimidine nucleotides in the acid-soluble fraction increased at one day after irradiation. This may explain, at least in part, the decreased rate of the incorporation of ^{3}H-orotic acid into the nuclear RNA fractions at this period. (auth)

41251 ULTRAVIOLET ABSORPTION SPECTRA OF γ-IRRADIATED CYTOCHROME-C. Yamauchi, Kotaro (Tokyo Metropolitan Univ.). J. Radiat. Res., 10: 36-44(Mar. 1969).

Difference spectra of γ-irradiated versus unirradiated solutions of cytochrome–C, of the amino acids constituting cytochrome–C and of aromatic amino acids have been investigated under various conditions. In the neutral solution of cytochrome–C, a broad increase in absorbance over the range from 2350 to 3420 Å with maxima at 2420, 2870 and 2970 Å, and a minimum at 2900 Å was observed. The over-all pattern in the observed difference spectrum of irradiated vs. unirradiated neutral solution of cytochrome–C may be explained in terms of two separate functions: one arises from the conformational change of cytochrome–C and the other comes out of the formation of new chromophore absorbing light around 2970 Å, on which the superimposition of the former is most likely to occur. (auth)

41252 EFFECT OF WHOLE-BODY X-IRRADIATION ON THE MICROSOMAL DRUG-METABOLIZING ENZYME SYSTEM IN RAT LIVER. Ichii, Shogo (National Inst. of Radiological Sciences, Chiba, Japan); Yago, Nagasumi; Kobayashi, Shigeru; Omata, Saburo. J. Radiat. Res., 10: 1-7(Mar. 1969).

Aminopyrine N-demethylase activity in rat hepatic microsomes decreased significantly after whole-body x-irradiation of 500 and 650 R. The process of the phenobarbiturate-induction of aminopyrine N-demethylase was found to be inhibited during quite an early period of the induction. Adrenalectomy caused marked decreases in the enzyme activity and cytochrome P-450 content of hepatic microsomes. The physiological significance of these and other metabolic changes was discussed in relation to the lethality of acutely irradiated animals. (auth)

41253 LIPID PEROXIDATION IN TISSUES OF WHOLE-BODY X-IRRADIATED RATS AND EFFECTS OF ADRENALECTOMY. Ichii, Shogo; Yago, Nagasumi; Omata, Saburo; Kobayashi, Shigeru (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 85-91(Sept.-Dec. 1968).

Lipid peroxidizing activities in the thymus, spleen, testis, kidney, brain, and liver were studied in intact as well as in adrenalectomized rats which were exposed to 450 or 650 R of whole-body x-irradiation. The contents of lipid peroxides in these tissues, removed from both control and irradiated rats, were found to be negligibly small as compared to the amounts of lipid peroxides formed in tissue homogenates during aerobic incubations at 37°C for one hour in the presence and absence of added ascorbic acid. Lipid peroxidizing activities determined by the in vitro incubation, varied considerably between tissues, and no correlation was observed between morphologically defined radiation sensitivity of tissues and levels of lipid peroxidizing activity. The activity in the liver increased to a considerable extent for some time after irradiation. A lag period was observed prior to the postirradiation increase in livers of intact but not of adrenalectomized rats irradiated with 450 R. The replacement therapy with cortisol acetate in adrenalectomized rats did not modify the postirradiation changes. The maximal level of lipid peroxidizing activity in livers of adrenalectomized rats was lower than that of intact rats, a finding that was in contrast to the fact that all of the adrenalectomized rats, but none of the intact ones, died within 5 days after 650 R. Lipid peroxidation, therefore, did not seem to be correlated with the mortality of irradiated animals. (auth)

41254 EFFECT OF X-IRRADIATION ON THE ACTIVATION AND INDUCTION OF RAT LIVER TRYPTOPHAN PYRROLASE BY SUBSTRATE AND HORMONE. Atsuta, Joe; Okamima, Shunzo (Nagasaki Univ.). J. Radiat. Res., 9: 105-11(Sept.-Dec. 1968).

The 500 R whole body x-irradiation inhibited the increase in holotryptophan pyrrolase activity which was induced by the single administration of cortisone or L-tryptophan in the adrenalectomized rats. However, no inhibitory effect of x-irradiation was found on the activity of holo-tryptophan pyrrolase which was induced by the combined administration of cortisone and L-tryptophan. It was suggested that the radiation effect on holo-tryptophan pyrrolase formation in the cortisone induction was the result of inhibited conversion of apo-tryptophan pyrrolase to holotryptophan pyrrolase, whereas apo-tryptophan pyrrolase formation was scarcely affected by x-irradiation. On the other hand, in the tryptophan induction an inhibition occurred in other processes, presumably in apo-tryptophan pyrrolase formation. The mechanism underlying the elimination of inhibitory effects of x-irradiation under the coexistence of cortisone and tryptophan was discussed. (auth)

41255 ^{32}P-RETENTION AND PHYSICAL CHANGE OF DNA IRRADIATED IN A REACTOR. Akaboshi, Mitsuhiko; Kawai, Kenichi; Waki, Asako; Maeda, Toshio (Kyoto Univ.). J. Radiat. Res., 9: 100-4(Sept.-Dec. 1968).

Salmon sperm DNA irradiated under various conditions in a reactor was examined for ^{32}P-retention and hyperchromicity. Observed results show that no essential relationship can be found between the two phenomena. When DNA containing water was irradiated at dry-ice temperature, the ^{32}P-retention was enhanced with increasing irradiation time (dose). (auth)

41256 UPTAKE OF ^{65}Zn AND ^{54}Mn BY IRRADIATED BACILLUS MEGATERIUM. Kiortsis, M. (Democritus Nuclear Research Center, Athens). Experientia, 25: 761-2(July 15, 1969).

The influence of varying doses of γ radiation on uptake of manganese and zinc by Bacillus megaterium was studied. Without irradiation the absorption of the two metals was rapid at first, then much retarded in the case of ^{54}Mn, while for ^{65}Zn it continued at a relatively high level for a long period of time. The uptake of ^{54}Mn was not significantly influenced by radiation, while the uptake of ^{65}Zn was decidedly enhanced by radiation. (H.L.W.)

41257 EFFECTS OF 14 MeV NEUTRONS ON THE REPRODUCTIVE CAPACITY OF HeLa S3 CELLS. Masuda, Kouji (Kyushu Univ., Fukuoka). J. Radiat. Res., 9: 116-28(Sept.-Dec. 1968).

A study was made on the loss of the reproductive capacity of HeLa S3 cells irradiated in vitro under both oxygenated and anoxic conditions with D-T neutrons (14 MeV) at 1, 20, 30, 150, and 400 rads/minute at 25°C and 37°C and with 180 kvp X-rays at 100 rads/minute at 37°C. RBE of neutrons measured at a range of 2 to 10% survival was 2.67 ~ 2.62 under oxygenated conditions and 3.83 ~ 4.61 under anoxic conditions. OER was 1.40 for neutrons and 2.16 for X-rays (gain factor was 1.54). Survival rate was dependent on the dose rate of neutrons under both anoxic and oxygenated conditions. There was evidence of recovery from sublethal damage of neutron irradiation under anoxic and oxygenated conditions after 5 hours. The average size of survival colonies 14 days after irradiation decreased with dose. The abortive colonies increased in number and decreased in average size with dose. (auth)

Immunology

Refer also to abstracts 41439, 41448, and 41467.

41258 (NYO-2265-15(Pt.1)) PROGRAM FOR THE STUDY OF TRANSPLANTATION OF TISSUES AND ORGANS AND RELATED TOPICS IN SURGICAL RESEARCH. Progress Report, June 16, 1968–June 15, 1969. Moore, Francis D. (Peter Bent Brigham Hospital, Boston, Mass.). Contract AT(30-1)-2265. 35p. Dep. CFSTI.

The clinical and experimental aspects of kidney and liver transplantation at the Harvard Medical School are discussed. These include; histocompatability studies in inbred beagles, improvements in immunosuppression and antilymphocyte serum production, improvement of allograph taken by pretreatment with subcellular fractions, experimental liver transplantation in dogs and in man, in the latter the clinical aspects were observed, and development of isobarically perfused kidneys where lactate and pyruvate data indicate sustained aerobic metabolism. Clinical developments during the past year centered around the problem of pulmonary insufficiency. Accomplishments during the past year included; description of the clinical syndrome in posttraumatic pulmonary insufficiency, measurement of the pulmonary extravascular water volume by the double indicator dilution technique as an indicator of ventilatory insufficiency, measurement of pulmonary lipid metabolism in normal and oxygen-perfused tissues using radioactive phosphates, and analysis of the kinetics of isotope exchange studies on body composition and skeletal size in relation to potassium content. A section on personnel and support is included as well as an extensive bibliography of related publications. (E.R.B.)

41259 HUMAN GROWTH HORMONE RELEASE DURING SLEEP: ELECTROENCEPHALOGRAPHIC CORRELATION. Parker, D. C. (Scripps Clinic and Research Foundation, La Jolla, Calif.); Sassin, J. F.; Mace, J. W.; Gotlin, R. W.; Rossman, L. G. J. Clin. Endocrinol. Metab., 29: 871-4(June 1969).

Five men slept in the sleep laboratory while continuing their usual daily pattern of working and eating. Blood was drawn every 30 min and the plasma separated for radioimmunoassay. Data regarding release of the growth hormone in sleep show that maximal concentrations occur soon after onset of sleep which are comparable to peak responses to arginine infusion. The data further suggest an association between EEG stages 3 and 4 and high growth hormone release throughout sleep, which in turn suggest interrelated neural mechanisms. (H.L.W.)

41260 SOLID-PHASE RADIOIMMUNOASSAY OF ESTRADIOL-17β. Abraham, Guy E. (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). J. Clin. Endocrinol. Metab., 29: 866-70(June 1969).

Antiserum was obtained from a ewe immunized with estradiol-17β-succinyl-bovine serum albumin conjugate. The dilution of antiserum that could bind 40 to 50% of the estradiol-17β-^{3}H was used for testing the affinity and specificity of the antiserum; this dilution was 1 : 20,000. Some steroids were tested for cross reaction with the antiserum and results are tabulated. When a comparison was made between radioimmunoassay and the double-isotope technique, it was found that the levels of estradiol-17β obtained by radioimmunoassay were 20 to 40% higher. (H.L.W.)

41261 STUDIES ON THE CELLULAR BASIS OF IgM IMMUNOLOGICAL MEMORY. Cunningham, A. J. (Wallaceville Animal Research Centre, Wellington, N. Z.). Immunology, 16: 621-32(May 1969).

Irradiated syngeneic recipient mice were used to test whether IgM immunological memory is carried by antibody-forming cells or by cells not releasing detectable antibody. The recipients were x-irradiated with 850 rad. An adoptive transfer system was used to demonstrate memory. Donor mice were injected intravenously with sheep erythrocytes and, at intervals thereafter, dispersed cells from their spleens were transferred to the lethally x-irradiated recipient mice, together with more antigen. The greatly increased plaque-forming cell responses in the spleens of irradiated mice receiving primed as compared to unprimed donor cells were taken as a measure of the level of IgM memory in the donor mice. Irradiated mice injected with 5 × 10^{5} spleen cells from donors primed with very high or very low doses of sheep erythrocytes produced fewer plaque-forming cells on challenge than did recipients of spleen cells from donors originally primed with 5 × 10^{8} sheep red cells. A plaque-forming cell fraction or a fraction totally free of plaque-forming cells was injected, with antigen, into each x-irradiated recipient, and the response of these mice was compared with that of a third irradiated animal that received unfractionated cells. In was consistently found that irradiated mice receiving plaque-free populations of cells responded as well as the controls, while no response was observed in mice receiving donor plaque-forming cells alone. It is concluded that IgM immunological memory is carried by cells that are not producing plaques. Memory cells and antibody-forming cells presumably belong to separate cell lineages. (BBB)

41262 IMMUNOSUPPRESSION. Parker, Charles W.; Vavra, John D. (Washington Univ., St. Louis). Contract AT(11-1)-1710. Progr. Hematol., 6: 1-81(1969).

Current concepts of the immune response are discussed with regard to interactions of antibodies and sensitized cells with antigen to produce an inflammatory response. Empirical observations on immunological tolerance are reviewed with relation to host responsiveness, immunogenicity, antigen dose, recovery from tolerance, partial tolerance and immune deviation, and enhancement. A general theory of immunologic tolerance is developed from the preceding observations. Approaches to the suppression of immunity include administration of antigen, administration of specific antibody, administration of other biologic reagents such as antilymphocyte serum, cytotoxic drugs, radiation, and surgical ablation of lymphoid tissue. Studies on radiation showed that radiation is more effective in reducing the humoral antibody response than the delayed hypersensitivity response. Effects of radiation are additive with other immunosuppressive measures. Radiation can accelerate recovery from partial immunologic tolerance, but not from complete tolerance. Cell death following moderate doses of radiation is largely limited to cells exposed during mitoses. However, small lymphocytes, spermatogonia, and oocytes are very sensitive to radiation death during interphase. It was demonstrated that local radiation to canine renal allografts, beginning at the time of transplantation, prolonged graft survival. The importance of immunosuppression in prevention of homograft rejection is discussed, and autoimmune diseases, or diseases in which antibodies directed against an individual's own antigens are formed, are discussed. (H.L.W.)

41263 AN EXPERIMENTAL STUDY ON THE PRODUCTION OF THE ANTITUMOR-ANTIBODY IN THE CANCER-BEARING MOUSE WITH SPECIAL REFERENCE TO THE EFFECT OF IMMUNIZATION WITH THE IRRADIATED TUMOR CELLS. Takamatsu, Hiroshi (Nihon Univ., Tokyo). Nichidai Igaku Zasshi, 28: 30-63(Jan. 1969). (In Japanese).

Mice of pure line (ICR/JCL) were immunized with irradiated tumor cells (Carcinoma 63 Bashford) as an antigen that received varying doses in vitro, and the immunization phenomenon in the cancer-bearing hosts was studied with regard to the anti-transplantational and anti-proliferational activities against the transplantation and growth of untreated tumor cells, changes in the tumor diameter, survivability, viability, etc. A detailed investigation was also made on the changes in the serum protein fractions, particularly that for γ-globulin where the presence of immunoglobulins were suggested in relation to the immunization phenomenon mentioned. As a result, the effect of immunization was found to be the most remarkable when a preliminary immunization with the tumor cells receiving 5000 R irradiation was made prior to the transplantation of untreated tumor cells. When a larger dose or a longer interval after the transplantation was used, the effect was found to be reduced. When the immunization had taken effect, the γ-globulin value was specifically increased, but if the value was low, the prognosis of the case was generally poor. (NSA of Japan)

41264 DELAYED REPULSION OF SKIN TRANSPLANTS AFTER INJECTION OF THORIUM DIOXIDE IN MICE. Noltenius, H.; Tan, S.; Knauf, I. (Univ., Freiburg i. B.). Naturwissenschaften, 56: 331(June 1969). (In German).

Following intravenous injection, thorium dioxide is deposited permanently in cells of the RES. Tissue damage particularly involves the lymphatic system. The lymphoid suppression causes a delay of transplant rejection. While control mice reject heterologous skin transplants after seven days, thorium injected mice show the rejection phenomenon only after eleven days. Neither infections nor toxic effects occur. (H.B.G.)

41265 IMMUNOGENESIS IN ANIMALS EXPOSED TO INTERNAL IRRADIATION WITH ^{32}P. THE RADIOPROTECTIVE EFFECT OF SEROTONIN. Szabo, St.; Krepsz, I.; Lukacs, Ecaterina; Csoegoer, St. (Academiei Republicii Socialiste Romania, Bucharest). Fiziol. Norm. Patol. Bucharest), 13: 267-71(May-June 1967). (In Rumanian).

The action of serotonin on the production of hemagglutinins and hemolysins in rats treated with ^{32}P and immunized with sheep red blood cells was studied. The results obtained showed that: Radioactive phosphate in doses of 120 and 150 μCi/100 g body weight inhibits the production of antibodies. Inactive phosphate does not have this effect. In the animals treated with serotonin and irradiated with ^{32}P immunogenesis decreases, but remains more intense than in the animals treated only with ^{32}P. Serotonin in doses of 10 × 1.5 mg/100 g body weight does not influence immunogenesis. Serotonin is also considered to have a slight radioprotective action in case of internal irradiation. (auth)

41266 THE RADIATION EXPOSURE-RATE EFFECT: ACTION UPON THE IMMUNE RESPONSE IN MICE. Carlson, Donald Eugene. Knoxville, Tenn., Univ. of Tennessee, 1968. 102p. Thesis.

Since the success of foreign-marrow transplantation in irradiated mice is dependent upon the rate of radiation exposure to the animals, the present study was undertaken to determine whether an exposure-rate-dependent suppression existed for antibody synthesis, and to establish the range of exposure and exposure rate over which an effect could be seen. Adult mice were exposed to ^{60}Co gamma radiation in doses of from 200 R to 1100 R at exposure rates ranging from 4 R/min to 100 R/min. Irradiated mice were injected with rat and sheep erythrocyte antigen at various times before or after irradiation, and the titer of circulating antibody was determined. Greater suppression of antibody production occurred at the higher exposure rates particularly when the total dose was in the sublethal range, 600 R and 700 R. Rate-dependent suppression of antibody production was dependent upon the type and dose of antigen, the route of antigen administration, and the time interval between antigen administration and radiation exposure. When antigen preceded irradiation by 12 hr, and the dose was 700 R, the suppression with 72 R/min was 64 times that with 8 R/min. The exposure-rate effect was demonstrated at the cellular level by culturing irradiated spleen cells in irradiated (950 R) syngeneic recipients. In this experimental system both primary and secondary antibody formation were differentially exposure-rate sensitive. At the level of maximum rate sensitivity for antibody formation against sheep erythrocytes (700 R), responses were depressed with increasing exposure rates to 40 R/min; insignificant additional depression occurred after exposure to high rates up to 100 R/min. The exposure-rate dependence of radiation mortality was determined, and the responses of mortality and immune suppression were compared; no correlation was observed. (Disser. Abstr.)

41267 THE ANTI-INFLAMMATORY EFFECT OF SOME IMMUNOSUPPRESSIVE AGENTS. Stevens, J. E.; Willoughby, D. A. (St. Bartholomew's Hospital Medical Coll., London). J. Pathol., 97: 367-73(Feb. 1969).

The effect of a variety of immunosuppressive agents, including ionizing radiation, on the acute and chronic inflammatory responses of the rat was studied. Irradiation was carried out in a 15-MeV linear accelerator, each animal receiving 600 rad over the whole body. The various immunosuppressants were tested for their effect on two models of acute inflammation, thermal injury and turpentine-induced pleurisy. For chronic inflammation, two models were used: a 2- and a 10-day-old reaction to complete Freund adjuvant injected intradermally into the hind foot, and granulation tissue formation around a cotton pellet. In contrast to the suppression observed in acute inflammatory responses, the same agents in single doses had no effect on either model of chronic inflammation, the exception being whole-body irradiation, which led to an 80% suppression of the 2-day-old reaction to Freund adjuvant and a 27% reduction in the formation of granulation tissue. A 3-day course of treatment with 6-mercaptopurine and cyclophosphamide caused 40% and 32% reduction of granulation tissue formation respectively. The other immunosuppresants tested were without significant effect. A weak correlation existed between the depression of lymphocyte counts brought about by immunosuppressive measures and the suppression of the inflammatory response. No such correlation existed between the polymorphonuclear cell counts of the treated rats and the intensity of the inflammatory response. (BBB)

41268 COMPARATIVE STUDIES ON BEHAVIOR OF ACID MUCOPOLYSACCHARIDE IN SCLEROSIS OF THE SKIN FOLLOWING BETATRON IRRADIATION, SCLERODERMY, AND A FEW SCLEROTIC DERMATOSES. Ishikawa, H.; Thies, W.; Schumacher, W.; Klaschka, F. (Freie Univ., Berlin. Rudolf Virchow-Krankenhous, Berlin). Hautarzt, 18: 174-80(Apr. 1967). (In German).

By histochemical means radiation-induced sclerosis caused by betatron particles was studied with respect to acid mucopolysaccharides and was compared with findings in scleroderma and several sclerotic dermatoses. No prinicpal difference was found between radiation-induced sclerosis and scleroderma. Characteristically, the formation of a (so-called) acid glycoproteid was found which showed reactions typical for mucopolysaccharide; this reaction occurred preferentially between collagen fibers or perivascular material. Obviously, acrosclerosis primarily involves a perivascular sclerosis followed by a coriumsclerosis. In sclerosis induced by betatron radiation, changes of the corium formed the initial process. Damage to fibroblasts or histiocytes by various insults followed by metabolic disturbances in the ground substance are briefly discussed. (H.B.G.)

41269 BONE MARROW AS SOURCE OF CELLS IN REACTIONS OF CELLULAR HYPERSENSITIVITY. III. ADJUVANT ARTHRITIS IN THE RAT. Putnam, Deborah A.; Lubaroff, David M.; Waksman, Byron H. (Yale Univ., New Haven). Arthritis Rheum., 12: 215-19(June 1969).

Adult Lewis rats were thymectomized, x irradiated (900 R), and given bone marrow cells from normal (BN X Lewis)F$_1$ donors. Passive transfer of adjuvant arthritis was carried out with lymph node cells of Lewis donors, sensitized 9 days earlier. The irradiated recipients showed clinical arthritis starting at 3 to 8 days and were sacrificed at 9 to 13 days. Live cell suspensions from affected joints and lymphoid tissues were assayed for cells derived from the F$_1$ hybrid marrow by an indirect fluorescence technique with Lewis isoantiserum against BN cells and fluorescein-conjugated rabbit antiserum against rat γ-globulin. In 8 rats, the percentage of cells containing BN antigen was found to be 42 to 65% in the joint lesions, 89 to 96% in bone marrow, 6 to 14% in the lymph nodes, and 25 to 38% in spleen cells. The results suggest that most cells in the joint lesions of adjuvant arthritis, in the special circumstance of x-irradiated, passively sensitized animals, are hematogenous and derived from bone marrow precursors. (BBB)

41270 GRAFT REJECTION. Feldman, Joseph D. (Scripps Clinic and Research Foundation, La Jolla, Calif). Contract AT (04-3)-779. Arch. Intern. Med., 123: 713-18(June 1969).

Graft rejection and its prevention are reviewed. Suppression of lymphoid tissue response is the primary aim in avoiding graft rejection. Reduction of lymphoid tissue mass and circulating lymphocytes, or both, can be accomplished by a variety of physical and chemical agents: irradiation of the whole body, extracorporeal irradiation of the blood, antilymphocyte serum (ALS), mechlorethamine hydrochloride (nitrogen mustard), and cortisone acetate. These agents effect a reduction of lymphoid mass and circulating lymphocytes. Similarly, thoracic duct fistula will accomplish the same result. And all of these help to prolong graft survival for varying lengths of time beyond the normal survival period. Some of these agents may accomplish more than diminish lymphoid cell number and decrease circulating lymphocytes. Cortisone, for example, exerts an antiinflammatory effect and may synergistically dampen the inflammatory reaction at the site of the graft. Total-body irradiation has profound effects throughout the body. It stimulates adrenal cortical hormone discharge, and it alters metabolism of organs with at least temporary imbalance of the internal milieu. (52 references) (BBB)

41271 SOLID-PHASE RADIOIMMUNOASSAY AND BLOOD LEVEL OF STAPHYLOCOCCAL α-TOXIN. Habermann, E.; Raeker, K. O.; Zeuner, G. (Justus Liebig-Univ., Giessen, Ger.). Arch. Pharmakol. Exp. Pathol., 262: 165-82(1969). (In German).

A solid-phase radioimmunassay was developed that utilizes antibodies covalently bound to cellulose. Its advantages and reaction conditions have been demonstrated with staphylococcal α-toxin. Sera of some rabbits, human plasma and especially native antitoxic sera contain precipitating antibodies which bind added radioactive toxin in proportion to the concentration of native toxin (inverse radioimmunassay). Native and labelled toxins disappear very quickly from the circulating blood of rabbits (half-life time below 5 min). After its disappearance from the blood, radioactive toxin cannot be redistributed into the circulation by injection of antitoxin. Previous injection of normal or antitoxic bovine serum delays the elimination of α-toxin. Previous ligation of both kidneys delays the elimination of labelled toxin from the blood stream considerably. Ligation of the ureters is less effective in this respect. (auth)

Ecology

Refer also to abstracts 41217, 41300, 41301, 41303–41306, 41316, and 41365.

41272 (PNE-956) ECOLOGICAL AND ENVIRONMENTAL EFFECTS FROM LOCAL FALLOUT FROM CABRIOLET. I. RADIATION DOSES AND SHORT-TERM EFFECTS ON THE VEGETATION FROM CLOSE-IN FALLOUT. Project CEP-67.3: Project CABRIOLET. Rhoads, William A. (EG and G., Inc., Goleta, Calif.); Platt, Robert B. (Emory Univ., Atlanta, Ga.); Harvey, Robert A. (San Bernardino Valley Coll., Calif.); Romney, Evan M. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Aug. 23, 1968. Contract AT(29-1)-1183. 65p. Dep. CFSTI.

Project CABRIOLET was a nuclear experiment in hard, dry rhyolite rock executed as part of the PLOWSHARE Program for developing the use of nuclear energy in excavation. CABRIOLET was detonated on January 26, 1968, at Nevada Test Site (NTS). An intensive dosimetry experiment was undertaken on the vegetation in the vicinity of the proposed ground zero (GZ) for CABRIOLET. Special thermoluminescent dosimeters were devised for distinguishing between β and γ radiation doses. By distributing dosimeters along vertical wires from near the ground's surface to a height of 1.5 meters, an attempt was made to measure the β fluxes. Dosimeters were also placed on the shrubs and trees and on plant phantoms. These dosimeters were established at 45 stations on a 95-degree arc, 610 meters from GZ and generally to the north, where the fallout was anticipated. The midline of the fallout pattern occurred near the western edge of the arc, where the highest γ doses measured were about 800 RADS. The β doses were high in the center of the fallout pattern but relatively low on the periphery. At the center of the pattern, the highest β dose was about 8,000 RADS, producing a β-to-γ dose ratio of 10. On the pattern's periphery, however, the ratio was about four. CABRIOLET was fired in the Great Basin Desert's southern extremity, which is dominated by two species of sage brush (Artemisia spp.). Two other shrubs, the juniper (Juniperus osteosperma), and the desert rose (Cowania mexicana), which are larger than the sage brushes, make up a conspicuous but infrequent part of the landscape. There are also two species of Mormon tea (Ephedra spp.) and hop sage (Grayia spinosa), which are subdominant, and several other perennial species occurring with much less frequency. During the first three months after CABRIOLET, no changes were observed in the vegetation, which had been heavily coated by radioactive dust from the fallout, and in some parts of the fallout pattern, by dust from heavily traveled Pahute Mesa Road. In May, the fourth month after CABRIOLET, certain changes previously associated with radiation damage became apparent in areas of the fallout pattern receiving the highest doses. By June and early July, some vegetation was dying or dead, and abnormal changes were observed in areas receiving as little as 150 to 200 RADS of γ radiation. Because all γ doses were generally low, it was concluded that β radiation was primarily responsible for the observed damage. The total doses were near the previously established doses required to damage and kill the vegetation being considered. (C.H.)

41273 A MATHEMATICAL MODEL OF THE TRANSPORT OF ^{137}Cs FROM FALLOUT TO MILK. Wilson, Daniel William. Fort Collins, Colo., Colorado State Univ., 1968. 152p.
Thesis.

The transport of fallout cesium-137 from nuclear weapons' tests to milk was investigated in a single dairy farm ecosystem, the Colorado State University Dairy Farm. Measurement of cesium-137 in total fallout deposition, surface air, soil, crops, and milk was made from June, 1962, through 1967. Results of the environmental survey and supporting field and laboratory experiments were used to determine transport mechanisms and rate laws. A deterministic model was constructed which included a model to predict fallout cesium-137 levels in vegetation, and a model to predict milk levels directly from the fallout rate. The fallout rate was expressed as proportional to the surface air levels of cesium-137 during the growing season. Other factors considered in the plant contamination model were foliar absorption, field losses due to weathering, and a time-dependent deposition velocity related to the growth curve for vegetative dry matter. The model not only accounted for variations of cesium-137 in local crops and milk with time, but in a more general form, predicted quarterly averages of cesium-137 in milksheds across the nation. In the general model, first and second quarterly milk averages were correlated with the surface air levels of the growing season of the previous year, while third and fourth quarterly milk levels were correlated with the air levels in the current growing season. The results of the study, in summary, were: Surface air levels during the growing season and the dry deposition mechanism provided a meaningful basis function for expressing the direct fallout rate of cesium-137 on crops. Indirect deposition to crops via uptake from the roots or plant-base were insignificant contamination pathways during measurable direct fallout. Deposition of cesium-137 from rainfall to crops was an ineffective contamination pathway because of concurrent wash-off. Prediction of cesium-137 in milk required, in addition to the air-to-plant model, consideration of feed-to-milk transfer coefficients and the seasonally varying feeding practices. (Disser. Abstr.)

41274 EFFECTS OF IRRADIATION ON SOIL, ROOT, AND LITTER MICROFUNGAL POPULATIONS IN A PUERTO RICAN RAIN FOREST. Holler, James Riley. Columbia, S. C.; Univ. of South Carolina, 1968. 75p.
Thesis.

Using both the dilution plate and a modified soil plate methods microfungi were isolated from soil, roots, and litter in two similar study areas in the Luquillo Experimental Forest in Puerto Rico during the summer of 1964. During the winter and early spring of 1965, one area was irradiated for 3 months with a 10,000 curie cesium 137 source. Microfungi were again isolated during the summers of 1965 and 1966 in both the irradiated and control areas. In 1965 and 1966 an additional area was similarly studied which had been mechanically cleared to simulate opening of the canopy by irradiation. All soil populations were significantly lower than all root and litter populations with one exception, the litter population of the irradiated area in 1966. Soil populations of the irradiated area were significantly higher than in the undisturbed control area in 1965. The most extreme change in total populations in the irradiated area was that in the litter populations in the 1966 investigation. Litter populations decreased from 39.4×10^4 per gram of sample in 1965 to 3.8×10^4 in 1966 while populations in the undisturbed control area increased from 35.1×10^4 to 64.4×10^4. Before irradiation, populations from like layers in the two principal study areas were similar, but there was very little similarity between populations of different layers. Similarity between like layers in both centers decreased in 1965. The trend was continued through 1966 for soil and litter populations. When either is compared with the mechanically cleared area, the similarity was less than between each other. Populations at various distances from the cesium source showed the root populations to deviate the most from the controls in 1965 and the litter populations deviated the most in 1966. Comparisons between populations isolated from alcohol treated plates in 1964 showed a similar trend to that of the dilution plates of the same year. In 1965 there was greater similarity between soil populations and between litter populations but root populations were less similar than in 1964. In 1966, similarity between soil and between litter populations decreased while similarity between root populations increased. Diversity of species in the soil and litter was greater in the area to be irradiated than the undisturbed control area before irradiation. After irradiation, the reverse was true. Population diversity for the root layer in the irradiated and undisturbed control areas was similar during all three sampling periods. The root population in the mechanically disturbed area was more diverse than root populations in the other two areas during 1965 whereas in 1966 it was less diverse. No correlation between pH, root depth, or litter depth and microfungal populations was noted. However, increased temperatures could have been a factor affecting microfungal populations in those areas where the canopy of the forest was opened. Most direct effects of irradiation were noted in the litter population, while effects on the soil and root population appeared to be primarily indirect. (Disser. Abstr.)

41275 THE EFFECT OF BIOTIC COMPLEXITY AND FAST NEUTRON RADIATION ON ^{137}CS AND ^{60}CO KINETICS IN AQUATIC MICROCOSMS. Ragsdale, Harvey Larimore. Knoxville, Tenn., Univ. of Tennessee, 1968. 188p.
Thesis.

Aquatic microcosms consisting of various combinations of physical components (soil, water, and container surface) and biological components (Physa heterostropha, Najas flexilis, and Elodea canadensis) were used to determine the effect of increased biotic complexity on mineral cycling parameters. The stability of mineral cycling parameters was tested by stressing selected complexity levels with sublethal and lethal doses of fast neutron radiation. Replicate microcosms were prepared for each experiment and equilibrated in a controlled environment chamber which was maintained at 16 C, 75-ft-c light intensity on a 12-hour light-dark cycle. One microcurie each of ^{137}Cs and ^{60}Co was added to the water component of each microcosm and changes in compartmental activity were determined by sacrificing replicate microcosms at fixed time intervals with subsequent radiometric analysis. Generalizations from this study were that cycling parameters for different elements were dissimilar in less complex systems but converged toward similarity as complexity increased; microcosm components had one or more mineral cycling roles, some of which changed with complexity levels; increased functional complexity had the greatest effect on mineral cycling, although an increase in unifunctional species modified the mineral cycling parameters; ecosystem stability was related to the sensitivity of the biological interactions and not necessarily to the sensitivity of the organisms; and on the basis of mineral cycling parameters, the simpler microcosms were less stable than the complex ones to a moderate stress (sublethal dose), but more stable than complex systems when subjected to an extreme stress (lethal dose). The use of microcosms as ecological research units provides a means of performing experiments which would be difficult or impractical to conduct in nature, but the results are subject to the criticism that they may not be representative of a naturally occurring ecosystem. However, if certain microcosms designs can be shown accurately reflect an ecosystem, then microcosms may be used to test the effect of unusual environmental stresses and hypotheses about ecosystem behavior. (Disser. Abstr.)

Genetics and Cytogenetics

Refer also to abstracts 41365, 41467, 41468, 41499, 41501, and 41504.

41276 (CONF-690703-2) POTENTIAL USE OF TARGET ATOM IRRADIATION IN CONTROL OF MUTATION INDUCTION. Koo, F. K. S. (Puerto Rico Nuclear Center, Rio Piedras). [1969]. Contract AT(40-1)-1833. 9p. Dep. CFSTI.

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash.

Preliminary results are presented on a method for specific mutation induction. Seeds of Arabidopsis thaliana were irradiated with monochromatic x rays (mainly 14.10 and 14.16 keV) receiving a total dose of 5.1 kRad. Some of the seeds had been previously labeled at timed intervals with 5-bromouracil deoxyriboside (BUDR) to provide a target atom which would be incorporated into specific genes depending on at which stage of DNA synthesis the treatment was applied. Seedling mutations were scored in the second generation and included changes in color and form of cotyledons and first leaves. The frequencies of 13 seedling mutant types induced by the BUDR and x ray combination are reported for the different treatment periods. Specific types of mutants were not limited to particular treatment periods but were spread over several. It is concluded that further research is needed for evaluation of the method. (M.M.B.)

41277 (NYO-1979-31) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Progress Report, June 1, 1968–May 31, 1969. Green, Earl L.; Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). June 30, 1969. Contract AT(30-1)-1979. 11p. Dep. CFSTI.

Research in progress on the genetic effects of radiation on populations of mice is summarized. Among the topics discussed are possible recessive visible and lethal effects of ancestral spermatogonial irradiation and the heritability of the observed traits; attempts to repopulate the testes of irradiated mice through parabiotic union with non-irradiated mice; allophenic combinations of radioresistant and radiosensitive strains of mice; measurements of the fitness of heterozygous mutations which are known to be deleterious when homozygous; the genetic analysis of various enzymatic variants found among laboratory and natural populations; and the study of the shambling and furless mutations in mice. (M.M.B.)

41278 (ORO-1747-15) RADIATION GENETICS AND RADIATION RESISTANCE IN PEANUTS. Progress Report, November 1, 1966–June 30, 1969. (North Carolina State Univ., Raleigh). Contract AT(40-1)-1747. 12p. Dep. CFSTI.

Research is reported on selection for radiation resistant peanut strains, the breeding value of the macromutant (a mutant recognizable as a single plant), development of a mutation breeding model, and the most efficient timing of irradiation in the breeding cycle. Programs are discussed which are designed to evolve high yielding and balanced breeding populations with proper techniques of irradiation and selection. (M.M.B.)

41279 (ORO-2909-8) THE NORTHWARD MIGRATION OF CITRUS BY MEANS OF RADIATION-INDUCED MUTATION. Progress Report, October 1, 1968–June 30, 1969. (North Carolina State Univ., Raleigh). July 1969. Contract AT(40-1)-2909. 49p. Dep. CFSTI.

Vegetative buds of Citrus sinensis were exposed to varying doses of x rays and the effects of winter environment on their descendents were studied. Thirty-four selected survivors were transplanted to greenhouses for regrowth and four of these were compared in replicated survival trials unprotected on the south coast of North Carolina. Simultaneously, replicated trials of varieties of known hardiness class and of classes of winter injury to single independent plants showed that differences of relatively small magnitude in winter injury could be discriminated among replicated individual scions but that the same criteria for classes of injury on independent plants gave statistically unreliable information for the individual plant components of the class even though the classes themselves could be weakly discriminated. A separate abstract was prepared for a paper on mutations in peanuts and citrus fruits. (H.L.W.)

For an abstract of the individual paper see: 41280.

41280 (ORO-2909-8, Paper 1) MUTATIONS AND BIOLOGICAL IMPROVEMENT. Gregory, Walton C. (North Carolina State Univ., Raleigh). 32p.

The probability of incorporating a rare favorable mutation into the breeding population of the organism is discussed. A mathematical model for expressing the degree of conformity between a biological characteristic and the demands of its environment is described. Mutation breeding experiments with the peanut, Arachis hypogaea, were conducted. Dried seeds were x-irradiated and the number of visibly mutant plants and their estimated degree of departure from the control type were determined in succeeding generations. Equations are given for second generation mutant plant frequency in relation to decreasing magnitude of change. Results led to the following conclusions: if a change in phenotype is large it will very likely be both rare and unfavorable; if it is very small it will have approximately 50% probability of being favorable and will occur with a frequency correlated with its diminishing size. The importance of probability laws of magnitude of change in hybridization as well as in mutation for plant-improvement is emphasized. Experiments were conducted on x-radioinduced mutations in vegetative buds of several varieties of oranges grafted on Poncirus trifoliata. X-irradiated buds were subjected to the natural selection of winter through four test stages at Raleigh, North Carolina. Tolerance of hybrids to various temperatures was studied. (H.L.W.)

41281 (UCSF-10-P-2-71) ON THE GENETIC EFFECTS OF IONIZING RADIATION. Wolff, Sheldon (California Univ., San Francisco. Lab. of Radiobiology). Jan. 1969. Contract AT(11-1)-Gen-10. 19p. (CONF-690118-1). Dep. CFSTI.

From 2nd Congress of the National Academy of Medicine, Mexico City, Mex.

Data accumulated by various workers on the genetic effects of radiations on the fitness of animal populations are summarized. Emphasis is placed on criteria that help to distinguish between radioinduced chromosomal aberrations and point mutations. The difficulties of estimating the genetic hazards of radiations to human populations from the mutation rates calculated for animals are discussed. (M.M.B.)

41282 EFFECTS OF ULTRAVIOLET IRRADIATION BEFORE MATING IN SACCHAROMYCES CEREVISIAE. Takahashi, Toshiaki (Brewing Science Research Inst., Osaka). Bull. Brew. Sci., No. 14, 49-60(1968).

Haploid strains of Saccharomyces cerevisiae were uv-irradiated before mating. The sporulation rate of the resulting hybrid was not affected, but ascospore germination was slightly inhibited. Irregular segregation of nutritional markers showed about twice as much increase as controls. Irregular segregation of mating types was very pronounced. Crossing of a uv-irradiated strain with a non-irradiated strain produced a hybrid showing low crossing over in adjacent regions on chromosome III. (NSA of Japan)

41283 THE ULTRAVIOLET ACTION AND MUTATION SPECTRA OF BACILLUS SUBTILIS. Morowitz, Harold Joseph. New Haven, Yale Univ., 1951. 69p.

Thesis.

The ultraviolet lethal action, absorption, and mutation spectra were experimentally determined for dry spores of the bacterium Bacillus subtilis. The mutation spectrum studied was for a class of biochemically deficient mutants, and is the first spectrum of this type that has been obtained. The absorption spectrum possesses peaks at 2770 Å, 2630 Å, and 2700 Å which are attributed to protein, nucleic acid and some unspecified component. The action spectrum indicates that specific cellular chromophores are responsible for the lethal action. Even greater specificity is indicated for the mutation process by the spectrum obtained. Both lethal action and mutation spectra peak in the neighborhood of 2700 Å. The lethal sensitivity of Bacillus subtilis spores to X-rays and cyclotron-accelerated deuterons was measured. The results of the irradiations with ultraviolet light, X-rays and deuterons are in agreement with the target theory of D. E. Lea, if one assumes that the spores are diploid. (Disser. Abstr.)

41284 A STUDY OF THE EFFECTS OF X-RAY IRRADIATION ON A QUANTITATIVE CHARACTER, PUPAL WEIGHT, UNDER VARIOUS GENETIC BACKGROUNDS OF TRIBOLIUM CASTANEUM. Chigusa, Sadao Ishiwa. Lafayette, Ind., Purdue Univ., 1968. 292p. Thesis.

The effects of induced mutations on a quantitative character, pupal weight, under various genetic backgrounds, were studied in five populations of Tribolium castaneum, each uniquely identified by previous selection history but all had originated from the Purdue Foundation "+" Population. Three levels of irradiation, 0 R, 1000 R, and 2000 R were used. Estimated mean (mg) and heritability for each population were respectively — Population 1: 6.18 ± 0.01, 0.36 ± 0.04; Population 2: 3.66 ± 0.01, 0.45 ± 0.07; Population 3: 2.19 ± 0.01, 0.55 ± 0.05; Population 4: 1.55 ± 0.01, 0.28 ± 0.06; Population 5: 0.99 ± 0.01, 0.15 ± 0.04. One generation of random mating intervened between the irradiation and the measurement of induced changes in mean and variance. Genetic variance was observed by means of parent-offspring regression, a simulated selection and full sib covariance. Each population reacted differently to irradiation, and average change of mean (ΔM, X10 μg) and genetic variance (ΔV_G) were found to be as follows — Population 1: 3.15 ± 1.19, −67.69 ± 75.95; Population 2: −1.18 ± 0.75, −18.69 ± 29.12; Population 3: 5.50 ± 0.63, −6.49 ± 12.19; Population 4: −2.45 ± 0.55, 18.09 ± 13.11; Population 5: 2.45 ± 0.60, 1.50 ± 9.54. The genetic variance increment divided by the existing genetic variance before irradiation, which may be called as the relative increase of genetic variance was the following (per R, $\times 10^{-4}$) — Population 1: 3.04 ± 0.40; Population 2: −1.90 ± 0.48; Population 3: −0.88 ± 0.76; Population 4: 5.40 ± 1.62; Population 5: 0.64 ± 1.52. The observed dependencies of ΔM as well as ΔV_G on the genetic backgrounds in this study were examined as a function of gene frequency and mutation rates in both directions. No epistasis, no inbreeding, no selection, no multiple alleles and a large random mating population under a genetic equilibrium were assumed in a simple genetic model. Change in gene frequency due to mutation was also assumed to be small. Under the genetic model introduced in this study, the experimental results in ΔV_G could be interpreted only in the case where mutation rates in two directions are different, namely, the rate of mutation ($a \rightarrow A$) is higher than the other. However, the behavior of ΔM could not be explained easily under this model. To some extent, effects of natural selection and finite population size of ΔM and ΔV_A were discussed, but further studies of the experimental as well as the theoretical aspects of the effects of X-rays irradiated on this quantitative character of Tribolium should be highly desirable. (Disser. Abstr.)

41285 WHOLE AND PARTIAL MUTATIONS INDUCED IN THE DEVELOPING EMBRYO OF MAIZE BY X-RAYS. Fujii, Taro (National Inst. of Genetics, Misima, Japan). Seiken Jiho, No. 20, 55-61(Dec. 1968).

Pollen grains of a normal strain of Zea mays with Bz- and Yg$_2$-genes were applied to the silks of a recessive stock which was grown in pots. The pollinated plants were exposed to 1 kR x irradiation of 38 R/min 24, 48, and 72 hours after pollination. The middle part of each cob was adjusted vertically to radiation. Consequently, x ray dosage varied slightly along the length of the cob on account of the difference in distance between machine target and the location of young embryos on the cob. At any given time only a few plants could be irradiated with the same dose rate; therefore the interval between pollination and irradiation varied. Mutation from Bz- to bz was observed in the endosperm of F$_1$ seeds. All crossed seeds were sown in the greenhouse after examination, and mutation from Yg and yg was scored in the F$_1$ seedlings. Results from pollen irradiations are included from earlier experiment. Whole and partial mutation frequencies were examined. Details of the results are reported and the development of the fertilized egg cell in relation to mutation frequency is discussed. (auth)

41286 GENETIC ANALYSIS OF A MUTANT OF BACILLUS SUBTILIS PRODUCING ULTRAVIOLET-SENSITIVE SPORES. Munakata, Nobuo (Tokyo Univ.). Mol. Gen. Genet., 104: 258-63 (July 3, 1969).

A mutant of Bacillus subtilis, uvssp-42-1, producing uv-sensitive spores was studied genetically. By treatment of the cells with DNA prepared from a uvr strain two types, uvs-42 (Hcr$^-$) and ssp-1 (Hcr$^+$), of transformants producing uv-resistant spores were obtained. Only strains having both types of mutations together produced uv-sensitive spores. (auth)

41287 CYTOGENETIC STUDIES IN SUBJECTS WITH CHRONIC OCCUPATIONAL EXPOSURE TO LOW DOSES OF IONIZING RADIATIONS. Froni, A.; Ghezzi, I.; Cappellini, A. (Univ., Milan). Med. Lavoro, 60: 169-74(Mar. 1969). (In Italian).

Cytogenetic studies were performed in 12 radiation workers with chronic exposure to low doses of radiations (accumulated doses: <1 to 12 rem), and in two workers who were exposed to higher doses (accumulated doses: 30 and 100 rem). The frequency of unstable chromosome changes was significantly higher in the individuals exposed in comparison with the control group. The two subjects with higher lifetime exposures, showed a highly significant difference in the frequency of unstable chromosome aberrations when compared both with the unexposed controls and with the subjects with lower dose exposure. No significant differences were observed in the incidences of stable chromosome changes. (auth)

41288 PROBLEMS OF RADIATION MUTAGENESIS. Dubinin, N. P.; Tarasov, V. A. (Inst. of General Genetics, Moscow). At. Energy Rev., 6: No. 3, 101-212(1968).

Some fundamental problems of radiation-induced mutagenesis are reviewed. Initial lesions of the genetic cellular mechanism were recently shown to be reversible. The paper discusses in detail the varying probability of the fixation of premutational damage as mutation depending on intra-cellular conditions and some other modifying factors are discussed. Much attention is paid to the kinetics of mutagenesis induced by single, fractionated and prolonged irradiations. An especially important aspect of the problem is the study of the types of chromosome aberrations successively varying throughout the cell cycle. Based on this, recent knowledge with respect to this issue, and a hypothesis aimed at explaining the nature of this phenomenon and at foretelling the time point of chromosome aberration transition into chromatid aberration are reviewed. Comments are made on the hypothesis of the limited number of the sites where chromosome exchange may occur. (auth)

41289 GENETIC EFFECTS OF RADIATION. Spar, Irving L. (Univ. of Rochester, N. Y.). Med. Clin. N. Amer., 53: 965-76 (July 1969). (UR-49-1066).

A general discussion is presented on the effects of radiation on genetics; the discussion is limited to events which affect the germ cells and their influence on the next generation. Studies on spontaneous mutations in animal populations have led to the concept of genetic death which states that the lethal mutant gene is eliminated from the population by death of the individual carrying the mutation. This leads to an equilibrium of mutation vs. selection. The significance of recessive mutations in animal and human populations is discussed. It is pointed out that radioinduced mutations occur with a greater frequency than spontaneous mutations, and since they are usually deleterious or lethal, there will be a greater load of detrimental genes in future generations. The significance of chromosome aberrations and point mutations in radiation genetics is reviewed. The importance of exposure of human populations to natural radiation, fallout, diagnostic radiography, and diagnostic applications of radioisotopes is discussed. (H.L.W.)

41290 MUTATION BREEDING IN BULBOUS IRIS. Hekstra, G.; Broertjes, C. (Center for Flower Bulb Research, Lisse, Netherlands). Euphytica, 17: 345-51(1968).

In selection studies of the sterile iris cultivar Wedgwood, the bulbs were x irradiated. The aim was to induce flower color mutations in this early flowering cultivar which is specially suitable for early forcing. Since no data on radiosensitivity were available, it was necessary to determine which dose is optimal, what developmental stages are preferred, and whether a stage of increased radiosensitivity exists. An acute dose of 1500 rad was lethal, whereas after 500 rad no visible changes were observed. The optimal dose, ~1000 rad, depended on the developmental stage of the bulb; vis. the younger and less differentiated state, the higher the optimal dose (1100 rad). Older bulbs, even when stored at a temperature of 30°C, during which the growing tissues do not develop, were more sensitive, the optimal dose decreasing towards 700 rad after 8-month storage. Bulbs stored at 17°C also showed an increasing radiosensitivity with time; 1100 rad was almost lethal for bulbs irradiated on October 2nd and later, whereas 800 rad was too large a dose after November 13. The optimal time of irradiation is directly after harvesting the bulbs in August, and the optimal dose is ~1000 rad. The size of the bulb was not an important factor in radiosensitivity. Since 1964 almost 6000 bulbs, representing 25,000 growing points, have been irradiated. So far, over 160 flower-color mutants, ranging from pale to dark blue, with or without purple, have been obtained. Moreover, a number of other mutants (more flowers per stalk, other form of the flower, or different flowering dates) have been observed. (BBB)

41291 CYTOLOGICAL STUDIES ON AN INVERSION IN BARLEY. Kreft, Ivan (Lund Univ., Sweden). Hereditas, 62: 14-24(1969).

Meiosis in a barley stock heterozygous for a chromosomal inversion was studied in fixed spikes from an x-ray-induced paracentric inversion-heterozygous stock. Most of the configurations of anaphase I and anaphase II were such as would be expected in inversion-heterozygous plants. In a few cases anaphase configurations were different. Besides heterozygosity of the inversion the reason for such configurations probably included stickiness, breakage of the dicentric chromatid in early anaphase I, spontaneous breakage and fusion of chromatids, and hiding of the acentric fragment among other chromosomes. Usually it was difficult to distinguish the 2 dicentric chromatids in 1 chromosome pair. Thus, expected configurations, exhibiting 2 bridges in 1 chromosome pair and 2 acentric fragments, may be sometimes registered as 1 bridge and 2 fragments. The last configuration is much more frequent than the first, though the opposite was expected. For the same inversion the x-ray-induced heterozygotes had fewer abnormalities in 1961 than their progenitors in 1957. Extreme fragmentation of chromatin material was detected in 9.2% of microsporocytes of 1 plant, and in dyads of the same plant unusual abnormal nuclei were observed. (BBB)

41292 RADIATION-INDUCED HERITABLE VARIATION OF QUANTITATIVE CHARACTERS IN WHEAT. Dumanovic, J.; Denic, M.; Ehrenberg, L.; Bergstrand, K. G. (Stockholm Univ.). Hereditas, 62: 221-38(1969).

The possibilities of inducing, by irradiation of kernels or seedlings, heritable variations in polygenically controlled quantitative characters of hexaploid winter wheat were studied. The variations induced in an old, stable variety (Bankut 1205) were compared with those in relatively new varieties of hybrid origin (013 and 39 × 837). After exposure of dormant seeds to various doses of ^{60}Co γ rays, variations of the yield, measured as grain weight per plot or per plant, and of the plant height were determined. In other experiments seeds pregerminated for 48 hr were immersed and cultured for 15 days in solutions of $NaH_2{}^{32}PO_4$. The initial activity was 5 or 10 μCi/seed. This treatment caused some growth inhibition of seedlings. The mutagenic effectiveness, measured as interline variance components, σ^2, after γ irradiation of seeds was about the same in the old variety (Bankut 1205) and in a relatively new variety of hybrid origin (013), as revealed in studies in X_5 of random or selected samples of lines. The effect was more clear-cut in Bankut 1205 because of the higher stability of the control material of this variety. The negative shift of mean values in the yield variables was larger, however, in the old variety. In contrast to γ rays, ^{32}P was relatively inefficient mutagenically. In a further selection, from X_5 of high-yielding lines of the variety 013 several lines surpassed the standard by 20 to 30% in grain weight per plot. A similar selection from the ^{32}P-treated 013 and 39 × 837 was less effective. It was concluded that moderate or low γ-radiation doses are preferable in breeding studies in the isolation of high-yielding mutant lines free from deleterious mutations. High doses seem to induce too many mutations per cell with a negative combined effect. This situation, not observed to follow irradiation of diploid barley, may be a consequence of the genetical buffering capacity of a polyploid. (BBB)

41293 THE PROBLEM OF INDUCED STERILITY: A COMPARISON BETWEEN EMS AND X RAYS IN ARABIDOPSIS THALIANA. **Mesken, M. (Foundation for Agricultural Plant Breeding, Wageningen, Netherlands); van der Veen, J. H. Euphytica, 17: 363-70(1968).**

Mutagen-induced sterility was studied in Arabidopsis by experiments that compared effects of x rays and ethyl methane sulfonate (EMS). Seeds, 10 weeks old, of the very early flowering pure line, Landsberg-erecta, were treated with EMS (dry seeds) or with x rays (presoaked seeds). EMS (8.3 and 12.5 mM) was applied for 24 hr at 24°C, followed by 5 min rinsing with water. X rays (8 and 12 kR, dose rate 700 R/min) were given to the wet seeds. For a given treatment, M_2 fertility was correlated with M_1 fertility, but mutant frequency in M_2 was equal for the different M_1 fertility classes. It followed that efficiency in mutation breeding can be increased by preselection for fertility in M_1, and by using x-ray or EMS doses which do not make fully fertile M_1 sectors too rare. EMS was more efficient than x rays by a factor 4 at equal M_1 fertility, and a factor 3 at equal M_2 fertility. As a result of difference in fertility spectrum, fertility improvement from M_1 to M_2 was greater for x rays than for EMS. Considerable diplontic sterility and number of embryonic lethals (nongerminating seeds) accompanied the higher mutant frequency after EMS. Fortunately, part of the diplontic sterility can be preselected against in M_1 and maternally conditioned embryonic lethals can be selected against by discarding seed-lots from individual M_1 sectors which show reduced germination. (M_2 line selection may also be practiced against recessive embryonic lethals and seedling lethals.) (BBB)

41294 THE GEMINI-XI S-4 SPACEFLIGHT RADIATION INTERACTION EXPERIMENT. II. ANALYSIS OF SURVIVAL LEVELS AND FORWARD-MUTATION FREQUENCIES IN NEUROSPORA CRASSA. de Serres, F. J.; Miller, I. R.; Smith, D. B.; Kondo, S.; Bender, M. A. (Oak Ridge National Lab., Tenn.). Radiat. Res., 39: 436-44(Aug. 1969).

Samples of asexual spores of a two-component heterokaryon of Neurospora crassa, collected on Millipore filters or in suspension, were flown aboard the Gemini-XI spacecraft to permit an evaluation of the genetic effects of radiation in combination with spaceflight parameters such as weightlessness. A ground-base experiment was performed simultaneously as the control. The samples were exposed to different amounts of ^{32}P β-irradiation, and the survival levels and forward-mutation frequencies in the ad-3 region studied. Analysis of survival and forward-mutation frequency has been completed; characterization of the ad-3 mutants is in progress. The results show that in-flight and ground samples irradiated on filters do not differ significantly either in survival levels or forward-mutation frequencies, confirming the finding of the Gemini-XI blood experiment that no synergism exists between radiation and spaceflight parameters. Significant differences were found among samples irradiated in suspension, however. Levels of survival were higher and frequencies of forward mutation lower in the in-flight samples than in the ground samples. Since these differences do not agree with data from our tests, they may have been the result of anoxia caused by high temperatures in the spacecraft cabin, instead of protection against the genetic effects of radiation by weightlessness. (auth)

41295 ADDENDUM TO: MUTATION BREEDING OF DAHLIA VARIABILIS. **Broertjes, C.; Ballego, J. M. (EURATOM-ITAL, Wageningen, Netherlands). Euphytica, 17: 507(1968).**

It is reported that 5 radioinduced mutants of the cultivar Arthur Godfrey, a decorative dahlia with flaming red-orange flowers of good form and habit, were commercialized. These radioinduced mutants are: Autumn Harmony, cadmium-orange with scarlet center; Explosion, blood-red with bright yellow center, massive bloom, full at center and good habit; Holland Jubilee, light orange throughout, bloom firmer and more regular than the original cultivar; Progression, brick red throughout; and Rosy Mist, empire rose throughout. All radioinduced mutants have a similar size bloom as the original cultivar. A purple-flowering as well as a scarlet-red mutant will probably also be commercialized when enough material has been grown. In a joint program by a private plant breeding firm and the Association Euratom-ITAL, irradiation of the dahlia cultivar Authority resulted in a mutant, sold under the name The Governor. The radioinduced mutant The Governor has a deep copper-red flower; other characters are unchanged. It was constant in color over 3 yr of observation. (BBB)

41296 THE CHANCES OF GENETIC DAMAGE IN THE PROGENY OF A WOMAN TREATED WITH ^{131}I. II. EVALUATION OF THE GENETIC RISKS. Sobels, F. H. (Univ., Leiden). Folia Med. Neer., 11: 48-52(1968).

The estimation of genetic risks from ^{131}I treatments is considered. Being based on data concerning mouse oocytes, the available estimates-are only applicable if the response of human oocytes to both the mutagenic and chromosome-breaking action of gamma irradiation is not greater than that of mouse oocytes. The available data on cell-killing of oocytes in various species of mammals suggest that human oocytes, like those of rhesus monkeys, are far more resistant to cell-killing than those of the mouse. Estimates of gonadal dose rates for the first ^{131}I treatment administered to the thyroid-cancer patient in question amount to 0.005 – 0.01 rad/min for the first two days after treatment and 0.002 – 0.005 rad/min for the following 6-day period. Since such a dose rate would be expected to give very low yields of mutation in the mouse, permanent sterilization of patients following their cure is not considered to be indicated. It is recommended, however, that conception should be avoided during the first 12 to 18 months after treatment, because in the mouse a pronounced dependence of mutation induction on the interval between irradiation of conception has been observed. For the induced loss of sex-chromosomes, an estimate of 1 per cent would be obtained if chromosome breakage is indeed produced in human oocytes at the same rate as in the mouse. Risks arising from translocations and non-disjunction cannot be evaluated but are thought to be very small. The present risk estimate of 1 per cent sex-chromosome loss should be viewed in relation to a natural incidence of 1 per cent chromosome anomalies in all live-born children, which are additionally burdened with at least another 1 to 2 percent of heritable disabilities. (auth)

41297 OOGENESIS OF MORMONIELLA AND RADIATION-INDUCED MUTATIONS AT THE R LOCUS. Johnson, Choppala Devasahayam Sam. Washington, D. C., Howard Univ., 1968. 80p. Thesis.

Cytological and cytochemical investigations were made to establish an account of the morphology of the Mormoniella ovary. Attention was given to the study of oocyte differentiation and the development of its associated structures. Radiation induced mutants occurring at the R-locus have revealed gross structural modifications of the ovary. The ovaries of Mormoniella consists of 2 clusters of 4 parallel tapering ovarioles, each of which is differentiated into an anterior germarium followed by a series of (40-65) successively more developmentally advanced units composed of oocytes and their supporting nurse cell nests. Posteriorly the ovariole ends in a uterine sac within which mature eggs are stored. The uterine sac joins to form a lateral oviduct. Oogenesis begins with 4 consecutive synchronous divisions of the cystoblast resulting in the formation of a 16-cell cystocyte complex. The most posterior cell of this complex differentiates into an oocyte and 15 cells form a nurse cell nest. Intercommunication is by a system of ring canals. The developing oocyte is surrounded by follicle cells which originate in the mesoderm of the germarium, and are responsible for chorion formation. Growth and maturity end in chorion formations. Evidence indicates that this process is a quick one resulting in the degeneration of the nurse cell nuclei in one step. The follicular envelop is sloughed off just as the mature egg enters the lateral oviduct. (Diss. Abstr.)

41298 CHROMOSOME ABERRATIONS AND CULTURE TIME. Honda, T.; Kamada, N.; Bloom, A. D. (Atomic Bomb Casualty Commission, Hiroshima). Cytogenetics, 8: 117-24(1969).

Leukocytes from 17 survivors of the Hiroshima atomic bombing and 10 control persons of the same age group were cultured for 2 and 3 days. The survivors were all exposed to over 100 rad. Controls were at least 3000 m from the hypocenter and were exposed to less than 1 rad. A total of 5400 cells was examined, 200 from each of the 27 patients. Aberrations other than single or isochromatid lesions were seen in 0.6% of cells of the control subjects at 2 days of culture and in 0.8% of cells at 3 days of culture. Among the exposed, 7.0% of cells cultured for 2 days had these aberrations, which were seen in 8.7% of cells cultured for 3 days. Six cytogenetically aberrant clones were found in 5 of the 17 exposed survivors. Four of these were detectable from the 2-day culture results alone. Since previous studies of 171 heavily exposed survivors, using the 66 to 70 hr culture time, had enabled the authors to detect only 4 clone-formers, it was concluded that the shorter culture time enhances clone detection. In a previous study of older atom-bomb survivors, which involved only 3-day cultures, translocations were the predominant type of complex aberration seen. Similarly, in the present study, translocations were the most common aberration of the exchange type, and they were found about equally at both culture times. (BBB)

Health Physics and Safety

Refer also to abstract 43064.

Radioactive Contamination and Decontamination

Refer also to abstracts 40532, 40970, 41218, 41273, and 41316.

41299 (NP-17952) TURKISH ATOMIC ENERGY COMMISSION FIFTH ACTIVITY REPORT OF THE RADIOACTIVE FALLOUT LABORATORY, AUGUST 1967-JULY 1968. (Atomic Energy Commission, Ankara (Turkey)). 1969. 16p. (In Turkish and English). Dep.

Data are presented on the monthly average gross β activity in the atmosphere, the content of ^{137}Cs and ^{90}Sr in atmospheric precipitation, and the content of ^{90}Sr in milk samples as a result of fallout in Turkey between July 1967 and July 1968. (C.H.)

41300 (NYO-3446-13) RADIOACTIVE FOODCHAINS IN THE SUBARCTIC ENVIRONMENT. Annual Report, August 15, 1968-August 14, 1969. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). Contract AT(30-1)-3446. 110p. Dep. CFSTI.

Separate abstracts were prepared for each of the five sections of this report. (C.H.)

For abstracts of individual sections see: 41301-41305.

41301 (NYO-3446-13, Paper 20) ANALYSIS OF ^{55}Fe PRODUCED BY NUCLEAR TESTS AND ITS ENRICHMENT IN FINNISH LAPPS. Jaakkola, Timo (Helsinki Univ. (Finland). Dept. of Radiochemistry). 77p.

A method was developed to determine ^{55}Fe in biological material in which dried samples were wet oxidized using nitric acid and perchloric acid, after which iron was isolated by di-isopropyl ether extraction and cation exchange. To determine the radioactivity of ^{55}Fe, iron was electrodeposited on a copper plate. The radioactivity was determined with a 2 π gas-flow proportional counter. The determinations of inactive iron needed for ^{55}Fe determinations were carried out with an atomic absorption spectrophotometer. There was a heavy increase in the fallout ^{55}Fe content of plants in Finland from 1962 to 1963. The ^{55}Fe content of willow and birch leaves and of grass (Deschampsia flexuosa) reached its maximum level (88.5, 85.6, and 54.6 nCi/kg dry wt, respectively) in 1963. The ^{55}Fe content of lichen (Cladonia alpestris) reached its maximum level (96.3 nCi/kg dry wt) one year later, i.e., in 1964. The effective half-time of ^{55}Fe in lichen (Cl. alpestris) was 1.4 years. By using this value the biological half-time of ^{55}Fe obtained for lichen was 2.9 years. The ^{55}Fe content of reindeer meat was highest, 7.6 nCi/kg fresh weight, in the spring of 1965. The highest ^{55}Fe content of reindeer blood, 206 nCi/l blood, was found in the samples collected in the spring of 1965. The biological half-time of ^{55}Fe in reindeer blood was estimated to be 150 days. The ^{55}Fe content of the blood of the Lapps in March 1966 was 10.6 to 22.2 nCi/l blood for the men and for the women 16.5 to 35.1 nCi/l blood. These ^{55}Fe contents corresponded to the whole-body burdens of 92 to 167 nCi for the men and 101 to 260 nCi for the women. The ^{55}Fe level of blood (pCi/mg Fe) for the women at fertile age was about two times higher than that for the men. Over 98% of ^{55}Fe in the diet of the Sevettijärvi and Inari Lapps originated from reindeer meat, liver, and blood. Depending on sex and occupation group, 6 to 15% of ^{55}Fe in the diet of the Utsjoki Lapps was derived from salmon and cod caught in the Arctic Ocean. The ^{55}Fe content obtained for salmon was 1020 pCi/mg Fe (4.6 nCi/kg fresh weight) and that of cod 236 pCi/mg Fe (0.87 nCi/kg fresh weight) in the spring of 1967. The body burden of ^{55}Fe in Lapps varied in the spring of 1966 from 0.07 to 0.26% of the maximum permissible body burdens recommended by ICRP. The annual absorbed dose for the whole blood varied in different Lapp groups from 1.1 to 3.7 mRad, and that for erythrocytes from 1.9 to 6.6 mRad. (84 references.) (auth)

41302 (NYO-3446-13, Paper 21) BODY BURDENS OF ^{137}Cs OF FINNISH LAPPS IN SPRING 1969. Rahola, Tua; Hattula, Tuulikki; Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 5p. (CONF-690527-2).

From 5th R. I. S. Symposium, Helsinki, Finland.

The body burden of ^{137}Cs in Finnish Lapps has been measured since 1961 every year using a transportable whole-body counter installed in a truck. The results of the whole body counting measurements performed at Inari in March 1969 are shown. When the body burdens of the same individuals in 1968 and 1969 are compared an average decrease of 24 per cent in the whole group (49 persons) is noticed. The maximum ^{137}Cs-activity value of an individual reindeer breeder was in 1969 1.1 uCi. The decrease of the ^{137}Cs activity values of reindeer and Lapps shows presently an effective halftime of about 4 years. It depends on the consumption of lichen fields by the reindeer, on the biological decay of lichen, and the physical decay of the nuclide. (C.H.)

41303 (NYO-3446-13, Paper 22) THE PRESENT SITUATION AND ITS LATE DEVELOPMENT REGARDING THE ACCUMULATION OF ^{137}Cs, ^{90}Sr, AND ^{55}Fe IN THE ARCTIC FOOD CHAINS. Miettinen, Jorma K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 8p. (CONF-690317-5).

From Seminar on Agricultural and Public Health Aspects of Environmental Contamination by Radioactive Materials, Vienna, Austria.

The Finnish reindeer herding Lapps have been measured for total-body ^{137}Cs annually since 1961. The maximal values, average 1.5 μCi (males), were observed in 1965. Since then the body burdens have decreased with an effective half-time of about 4 yr, while that for the Southern Finns has been about 2 yr. The total dose commitment from ^{137}Cs to the Lapps will be 1.1 rem/30 yr (1955 to 85), to the Southern Finns 26 mrem/30 yr. The dose commitment for Lapps from the natural α-emitter ^{210}Po will be at least 3 rem/30 yr, which is about the highest that any population is known to receive from natural radionuclides present as internal emitters. The ^{90}Sr in the reindeer is nearly completely located in the bones, which are not eaten by man. Therefore, the food-chain breaks and ^{90}Sr is not transferred further to man in any mentionable degree from the reindeer. This was shown by analyzing blood and urine samples of 18 Skolt Lapps for ^{90}Sr. The Lapps contained 6.8 pCi ^{90}Sr and 70 mg Ca per 24 hr urine, and 4.6 pCi ^{90}Sr per kg of blood. Southern Finns contained 7.5 pCi ^{90}Sr and 220 mg Ca in urine, and 4.4 pCi ^{90}Sr/kg in blood, respectively (years 1964 and 1966 are fairly comparable, the maximal intake took place in 1965). The Lapps of the Inari region get about twice more ^{90}Sr, mainly from cow's milk, because of the feeding of lichen to the cattle during winter. The ^{55}Fe content of Lapps' blood in 1966 was 36 nCi/l in women, 18 nCi/l in men; and whole-body burdens were 250 and 150 nCi, respectively. (C.H.)

41304 (NYO-3446-13, Paper 23) ^{210}Po AND ^{210}Pb CONCENTRATIONS OF SOME WATER AND FISH SAMPLES FROM FINLAND. Kauranen, Pentti (Helsinki Univ. (Finland). Dept. of Radiochemistry). 6p. (CONF-690527-1).

From 5th R. I. S. Symposium, Helsinki, Finland.

The behavior of ^{210}Po and ^{210}Pb in aquatic food chains in fresh and brackish waters was studied using a number of water and fish samples collected from Finnish lakes and the Bay of Finland, and analyzed for these nuclides. Some preliminary data are given and estimates are presented on the α dose rate to man following the uptake of ^{210}Po in foods in a normal diet. (C.H.)

41305 (NYO-3446-13, Paper 24) STABLE LEAD AND RADIOLEAD (^{210}Pb) IN THE "ARCTIC" FOOD CHAIN. Kauranen, P.; Jaakkola, T.; Miettinen, J. K. (Helsinki Univ. (Finland). Dept. of Radiochemistry). 6p.

In connection with studies of ^{210}Pb in the environment and human food chains in Finland, a number of analyses of stable lead were also carried out. Preliminary results on stable lead as well as ^{210}Pb in lichen are given. It is seen that in samples from Lapland the ^{210}Pb concentration may be slightly higher, while the stable lead concentration is significantly lower than in samples from southern Finland. As a consequence, the specific activity of lead in lichen from Lapland is very high, above 1000 pCi/mg. In southern Finland the specific activity seems to be around 300 pCi/mg. In reindeer samples specific lead activities between 700 and 1000 pCi/mg were found in most cases. The lower value found for reindeer meat is subject to analytical uncertainties because of the very low lead concentrations. Results for human samples indicate that the average stable lead concentration of blood is about the same in Lapps and in southern Finns, while the ^{210}Pb concentration in the Lapps is about 2.5 times higher. This is obviously a consequence of the higher specific activity of lead in the arctic food chain lichen-reindeer-man. The average specific activity of lead in human blood was found to be 47 pCi/mg in Lapps and 20 pCi/mg in southern Finns. It seems obvious that lichen is the source of the high specific activity lead in the arctic food chain, and that this lead gradually becomes diluted with less active lead from other sources. (C.H.)

41306 (UCRL-50596) RADIOACTIVE DEBRIS FROM UNDERGROUND NUCLEAR EXPLOSIONS. 1. PHYSICAL AND CHEMICAL CHARACTERISTICS. 2. BIOLOGICAL AVAILABILITY OF THE RADIONUCLIDES TO AQUATIC ANIMALS. Harrison, Florence L. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 7, 1969. 28p. Dep. CFSTI.

Radioactive debris from the chimney area of two contained underground nuclear explosions was characterized as to particle size, radionuclide concentration, leachability, and biological availability to representative edible freshwater and marine animals. The particle-size distribution was quite similar for the two events even though the detonation conditions were different. For both events the fission products were in higher initial concentration than most of the activation products. The leachability of the debris radionuclides was determined in distilled water, synthetic seawater and 1 $\underline{M}$ ammonium acetate. The percent of the added radionuclide in the liquid phase and the leaching distribution coefficients were dependent on particle size, composition of the leaching solution, and solubility characteristics of the individual radionuclides. The biological availability of the radionuclides was was dependent on the amounts in solution and/or in suspension in the water. The amount of radioactivity accumulated by the animals varied with the radionuclide and with the species. In general, higher concentrations of radionuclides were observed in the visceral organs than in muscular tissue. The freshwater animals concentrated radionuclides of Ce, Mn, Ru, Zn and Zr/Nb quite rapidly but those of Co, Cs and Sb were accumulated slowly. The marine animals concentrated radionuclides of Ce, Cs, Mn, Ru and Zr/Nb quite rapidly while those of Co, Sb and Zn were accumulated more slowly. (auth)

41307 PLUTONIUM CONTENT OF SEVERAL INTERNAL ORGANS FOLLOWING OCCUPATIONAL EXPOSURE. Lagerquist, C. R.; Bokowski, D. L.; Hammond, S. E.; Hylton, D. B. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Amer. Ind. Hyg. Ass. J., 30: 417-21(July-Aug. 1969).

Tissue samples from several internal organs were analyzed for plutonium following the natural death of an employee of a plutonium production plant. This employee had two contaminated puncture wounds and several small inhalation exposures over a nine-year period. He was excreting minute but measurable quantities of plutonium in his urine since 1958. A body burden calculation based on these urine results indicated the presence of 13.5% of the maximum permissible amount at the time of death. An extrapolation of tissue analysis to the whole body indicated the presence of 2.5% of the maximum permissible amount. (auth)

41308 ^{137}Cs BURDENS IN THE ADULT POPULATION OF BUDAPEST. Andrasi, A.; Feher, I. (Central Research Inst. for Physics, Budapest). Kernenergie, 12: 134-5(Apr. 1969).

The ^{137}Cs activity originating from nuclear weapons tests was measured in persons considered as typical for the population of Budapest, by use of a whole-body counter. Values of ^{137}Cs burdens for the years from 1964 to 1967 are presented. The average yearly doses calculated from the measured activities are also given. (auth)

41309 SIGNIFICANCE OF SURFACE CONTAMINATION BY RADIOACTIVE SUBSTANCES FOR OCCUPATIONAL HEALTH. Hvostov, N. N.; Kostyakov, M. S. Gig. Sanit., 34: 37-41(Jan. 1969). (In Russian).

Experiments performed in a hot laboratory to determine the correlation between surface contamination by radioactive substances and radioactive pollution of the air in workplaces are reported. Results indicate that this correlation is not a direct one, as has been assumed by a number of authors, but is relatively complex and depends on various factors, in particular working conditions and the nature and size of the surface. In a hot cell in which no work is performed, the increase in air pollution is negligible even where no ventilation is provided. (Occup. Safety and Health Abstr.)

41310 DECONTAMINATION OF LEAFY VEGETABLES (LETTUCE, CABBAGE, SPINACH) CONTAMINATED WITH ^{137}Cs AND ^{85}Sr. I. EFFECT OF TEMPERATURE AND TREATMENT TIME. Paulus, K. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Lebensm.-Untersuch. Forsch., 138: 329-34(1968). (In German).

Effects of various combinations of treatment temperatures and times on removal of ^{137}Cs and ^{85}Sr from lettuce, cabbage, and spinach were studied. The effects of the treatments were similar for the 2 radioisotopes. Above temperatures of 50 to 60°C removal was improved. The rate of removal increased slowly above this temperature, and also indicated that short treatment at these temperatures was more effective than longer treatments at lower temperatures. In each case ^{137}Cs was removed more readily than ^{85}Sr. Decontamination was improved by shredding the samples before treatment. Following treatment for 15 min at 90°, $\sim$90% of the ^{137}Cs could be removed. After treatment for 30 min at this temperature from 75 to 80% of the ^{85}Sr was removed. Treatment for longer times did not appreciably increase the amount of ^{137}Cs or ^{85}Sr removed, but impaired the quality of the product. (BBB)

41311 STUDIES ON ENVIRONMENTAL CONTAMINATION BY URANIUM. I. ENVIRONMENTAL SURVEY OF URANIUM IN KAMISAIBARA VILLAGE, OKAYAMA PREFECTURE. Yamamoto, Takashi; Masuda, Kuniyoshi; Onishi, Noboru (Hygienic Lab., Okayama Prefecture, Japan). J. Radiat. Res., 9: 92-9 (Sept.-Dec. 1968).

In order to investigate situations of uranium contamination in Kamisaibara village where uranium mines are being developed, measurements have been made on the amounts of uranium flow in the streams since 1963, and uranium contents in soil and in farm produce since 1965 by counting system and fluorimetric method. As a result, it has been found that the mean amounts of uranium flow in the streams in each year is higher at the sampling spots where drainages of gallaries and the pilot refinery were disposed, and the amounts were between 5.39 and 204.5 mg per minute. At sampling spots about 2,000 m lower than gallery and pilot refinery drainages, the detectable amounts were 0 to about 30% more than detected amounts in each preceding year. In general, the spots where the element can be detected gradually move downward year by year. The uranium contents in soil sampled in the village were 1.9 to 4.0 μg per g of air-dried soil. Uranium was detected in all vegetables sampled in the village, and the contents were between 0.1 and 0.67 μg per g of ash, while it could not be detected in all the vegetables sampled in Okayama City. On uranium contents in soils and vegetables, however, no remarkable variation with time could be observed. (auth)

41312 FALLOUT ^{137}Cs IN BEER. Shiraishi, Yoshiyuki; Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 112-15(Sept.-Dec. 1968).

Cesium-137 concentration in Japanese beer was determined for samples during 1959 through 1967. It was found that the level of this nuclide in beer depends on the fallout rate to a great extent and the peak value in beer appears about 1.5 years after the period of the highest rate of ^{137}Cs fallout. The results on certain samples of beer, raw materials (malt, side materials and hops) and the spent residues indicated that almost all ^{137}Cs and K contained in raw materials were transferred to beer during the manufacturing process. (auth)

Dosimetry and Monitoring

Refer also to abstracts 40950, 40982, 40984, 41018, 41028, 41076, 41130, 41307, 41308, and 41336.

41313 (BNWL-1018) IN-PHANTOM DOSIMETRY OF $^{147}Pm_2O_3$ HEAT SOURCE IN RELATION TO CIRCULATORY SUPPORT SYSTEMS. Cross, F. T.; Sheppard, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 22p. Dep. CFSTI.

In-phantom predictions and measurements are presented for two cylindrical $^{147}Pm_2O_3$ radioisotopic heat sources of nominal 15 watt rating and containing 0.25 and 3.5 ppM ^{146}Pm impurity developed for use as implanted blood circulation support systems (artificial hearts) in man. The protocol for characterizing the dose-rate fields is discussed. A comparison of two computer codes is included—the conclusion being that the more versatile QAD-code is somewhat more accurate in predicting the measurements and is capable of predicting the phantom measurements to within the experimental error of ±20%. If the total source-shield weight is restricted to about 0.5 pounds, the ^{146}Pm impurity would need to be reduced an order of magnitude or to about 0.02 ppM for promethium heat sources to be competitive with the estimated dose-rates from electrorefined ^{238}Pu heat sources. This comparison is for a promethium heat source of twice the thermal rating of a plutonium heat source. For a total source-shield weight of 1.2 pounds (the full complement of shields utilized in the phantom measurements), the 0.25 ppM ^{146}Pm source produced dose-rates at 20 cm into tissue (the approximate location of the spleen if the source is placed on the left iliac) of about 35 mrem/hr. This could be reduced to about 20 mrem/hr by rotating the source 90°, taking advantage of the dose reduction from source self-absorption. It is misleading to compare bare sources rather than sources placed within a blood-pump subsystem as it is recognized that a significant dose reduction takes place by distance shielding alone. The first tissues encountered by the radiations emanating from a subsystem would probably be at distances greater than those in contact with a "bare" source. This will reduce the source surface dose-rate and thus the integrated dose-rate in the body. However, the dose to any one organ, like the spleen, may not change appreciably unless there is an interposed thickness of higher atomic number materials from the subsystems. A more logical comparison of promethium with plutonium would be the computation of dose-rates accrued by tissue from sources placed within a subsystem. Once suitable prototypes are developed, this comparison should be made. (auth)

41314 (IDO-12071) ANNUAL REPORT OF THE HEALTH SERVICES LABORATORY, 1968. Voelz, George L. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.). Mar. 1969. 39p. Dep. CFSTI.

Separate abstracts were prepared on six of the eight sections in this report. The other two sections include the introduction to the report and a summary of the 1968 medical branch statistics. A list of current publications by each branch and an organizational chart of the Health Services Laboratory are included. (E.R.B.)

For abstracts of individual sections see: 40532, 40856, 40876, 41130, 41315, and 41316.

41315 (IDO-12071, pp 8-13) DOSIMETRY BRANCH. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

Operational dosimetry activities are summarized including radiation exposure statistics and program improvements. Developments in special problem dosimetry are outlined including high-level gamma measurements, neutron dose determination, thermoluminescent dosimeter-film comparison, and reactor component radiation damage study. Research and development projects include personnel neutron threshold detectors, x-ray facility development, phosphor evaluation, and data processing. (W.H.K.)

41316 (IDO-12071, pp 25-31) ENVIRONMENTAL BRANCH. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.).

The environmental branch maintains on-site as well as off-site monitoring facilities for determining the concentration of radioactive materials in the atmosphere, the total suspended particulate matter and dust-fallout in the atmosphere, the radioactivity content of ground waters from seepage ponds and disposal wells, the ^{131}I and ^{90}Sr content of composite milk samples from the Idaho milk shed, and the ^{90}Sr content of wheat at harvest. In addition to these routine surveillance activities, the branch assists on an administrative or consulting basis, the activities of independent surveillance programs involving experimental sampling at selected major licensed nuclear facilities in the U. S., waste management programs, particle sizing and counting for contractors, evaluation of hazards to off- and on-site personnel, and the radiation safety of all personnel through routine and special monitoring in laboratories. Through controlled environmental release tests, the air-forage-milk-human food chain for ^{131}I was studied. The objectives of this study included: definition of variables affecting radioisotope transport, measurement of variables influencing observed behavior, and development of predictive models of the processes involved. The following projects were conducted and some concluded during 1968: determination of the effects of stomatal opening on deposition, development of a radioiodine metabolism model for cows, evaluation of filters capacities for molecular iodine, preparation and support of a field test grid, design and construction of an environmental chamber for controlled plant exposure studies, development of generation and measurement techniques for aerosols, deposition and retention studies for ^{131}I on Sudan grass, and $^{35}SO_2$ release studies over alfalfa. Research is currently underway in the following areas: experimental cloud exposure studies, development of a model for internal plutonium dosimetry, injection of gas into the lithosphere, water movement in unsaturated soils, movement of radionuclides in soils, and determination of tritium concentrations in snow, rain, and stream water. (E.R.B.)

41317 (ORNL-tr-2144) DANGERS OF RADIATION EXPOSURE DURING A MANNED SPACE FLIGHT: APPLICATION TO AN EARTH-LUNAR PROJECT. Genet, Michel. Translated for Oak Ridge National Lab., Tenn., from Radioprotection, 3: No. 2, 115-29(1968). 21p. Dep. CFSTI.

An attempt is made to evaluate the radiation doses, that astronauts will be likely to receive in a manned space flight according to the different types of radiation encountered in space. The various risks are considered in a general manner and applied more specifically to the case of an earth-lunar project. It is apparent from this analysis that the principal danger is from cosmic rays from solar eruptions. In fact, the dose equivalent derived from these solar proton fluxes might be several hundred rem even in the interior of the space capsule. Detection methods and possible means of protection against this type of radiation are discussed. (auth)

41318 (UCRL-71833) ESTIMATION OF THE MAXIMUM DOSE TO MAN FROM THE FALLOUT OF RADIONUCLIDES ON AGRICULTURAL LAND. Ng, Yook C. (California Univ., Livermore. Lawrence Radiation Lab.). June 12, 1969. 49p. (CONF-690303-2). Dep. CFSTI.

From Symposium on the Biological Implications of the Nuclear Age, Livermore, Calif.

A method is described for estimating the maximum internal dose that could result when radionuclides are released to the atmosphere and deposited on agricultural land. By means of this analysis, the nuclides that could contribute most to the internal dose could be identified, and the contribution of each nuclide to the total dose could be determined. The calculations required to estimate the maximum dose to the whole body are presented to illustrate the overall method. The results serve the basic aims of preshot rad-safe analysis and of guidance for postshot documentation. The usefulness of the analysis in providing guidance for device design is further pointed out. (auth)

41319 DOSE DISTRIBUTION OF β-RADIATION OF FISSION PRODUCTS IN THE TISSUE-EQUIVALENT MATERIAL. Osanov, D. P.; Tissen, M. J.; Radzievskii, G. B. (Inst. of Biophysics, Moscow). Health Phys., 17: 489-95(Sept. 1969).

A one-dimensional depth distribution of absorbed doses is found in the semi-infinite tissue-equivalent medium, on the surface of which there is an infinitely thin uniform layer of a mixture of ^{239}Pu prompt fission products. The calculations are made using the method of a single dose function based on experimental studies of dose distributions from wide monodirectional beams of monoenergetic electrons. The approximate formula $C(E_0 - E)^2(E + 0.51)^2$ is used for describing the shape of partial β-spectra. It is shown that at the depth of 0.007 g/cm^2, corresponding to the basal layer in the human skin, dose rate is slightly dependent (approximately by a factor of 2) on the fission product "age" (varying from 1 day to 1 yr) and consequently on the strongly varying spectral composition of the β-radiation. (auth) (UK)

41320 RESULTS OF MEASUREMENTS USING THE EXPERIMENTAL WHOLE-BODY COUNTER OF THE RADIATION PROTECTION CENTER OF THE GERMAN DEMOCRATIC REPUBLIC, 1965-1967. Poulheim, K.-F. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 12: 139-40(Apr. 1969). (In German).

The experimental whole-body counter at the Radiation Protection Center of the German Democratic Republic was used to measure the concentration of radioisotopes in personnel during 1965 to 1967. The radioisotopes measured were ^{58}Co, ^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, and

^{226}Ra. The personnel were selected from industry, medicine, and research. (E.R.B.)

41321 RADIATION DOSES TO THE RADIOLOGIST IN URETHROCYSTOGRAPHY OF THE MALE. Rytilae, Aaro; Perttala, Yrjoe (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenn., 57: 257-9(1968).

Personnel exposure was measured during 50 urethrocystographies on male patients performed by the method in general use in Finnish hospitals. The bladder was first filled with urographin, whereupon the urethra was roentgenographed while oil-soluble contrast medium was injected by the radiologist during the exposure. A lead rubber apron and gloves (0.25 mm Pb) were worn during the examinations, and the radiation field was kept as small as possible. For all the procedures the exposure data were: 70 to 75 kV, 60 mA-sec, total filtration 2 mm Al, and FSD (focus-skin distance) 100 cm. The measurements were performed by radiophotoluminescence dosimetry at 12 different sites on the body. The highest maximum doses of 280 to 1700 mR/50 examinations were registered on the left forearm, forehead, right shoulder and shoulder region, and the right forearm. As expected, smaller doses were recorded by the dosimeters under the rubber apron. The doses were converted to monthly doses in accordance with the norms of the Association of Finnish Radiologists, assuming that the radiologist has performed only urethrocystographies for a whole month. According to this, the highest dose (to the left forearm) would be 8150 mR/month. The left forearm, which was closest to the radiation beam, received slightly less than the maximum permissible dose. The dose of radiation to the forehead per single urethrocystographic examination was 29 mR. According to the recommendation of the ICRP, the maximum permissible dose to the head is about 400 mR per month, which means that the radiologist can perform 14 urethrocystographies per month if he is to keep within the permissible limit. Almost the same is true of both shoulder regions. (BBB)

41322 CONSIDERATIONS ON THE PERIODIC RADIOTOXICOLOGIC SURVEILLANCE OF THE NUCLEAR WORKERS EXPOSED TO THE RISK OF INTERNAL CONTAMINATION. Breuer, F.; Strambi, E. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Lav. Umano, 19: Suppl. 12, 53-65(1967). (In Italian). (RT/PROT(69)1).

The periodic radiotoxicological surveillance of the workers exposed to the risk of internal contamination has a double purpose: evaluation of the accumulation in the body and of the consequent doses received by the critical organs, and revelation and evaluation of possible accidental contaminations that may have escaped the environmental control. For each radionuclide, the levels of the controls in the urine will be established, keeping in mind the risks connected with each place of work, the time necessary for the effective removal of the radionuclide from the organism, the sensitivity of the laboratory methods, and the criteria of organization and economy. For a first evaluation of the results of the radiotoxicologic analyses it can prove useful to adopt proper levels of reference, for the choice of which two different criteria are suggested, respectively for the radionuclides at short and long periods of removal from the organism. (auth)

41323 RADIATION MONITORING SYSTEM IN SASEBO HARBOR. Akabane, Nobuhisa (Tokyo Atomic Energy Bureau). Genshiryoku Kogyo, 15: No. 3, 47-50(Mar. 1969). (In Japanese).

Unlike the case of ordinary atomic installations where the radiation control is carried out on their own responsibility, the radiation control in harbors subjected to the port-call of atomic warships must be performed by the Government. In the Sasebo harbor, from 1964 to April 1968, there were a total of 13 port-calls by U. S. atomic warships. When the atomic submarine *Swordfish* was in the harbor, the monitoring posts recorded radioactivities 10 to 20 times higher than normal. In this connection and for other reasons, the radiation monitoring system in the Sasebo harbor was strengthened. The radiation monitoring system in the Sasebo harbor is described in the following: fundamentals behind carrying out radiation monitorings in the harbor; occurrence of a problem at the port-call of the *Swordfish*; the exchange of the U. S.-Japan memorandum; expansion of the system of monitoring facilities, including monitoring posts, measuring instruments for monitoring boats, nuclide analyzers, etc.; strengthening of the monitoring set-up for personnel, the monitoring activities, and reporting and announcing the results of monitoring; the first port-call of a U. S. atomic submarine after the *Swordfish* problem. (NSA of Japan)

41324 BUILD-UP EFFECT OF HIGHLY ENERGETIC BREMSSTRAHLUNG IN THE GeV REGION. Zywietz, F.; Kuenkel, H. A.; Staehler, F. (Univ., Hamburg). Naturwissenschaften, 56: 330(June 1969). (In German).

High energy bremsstrahlung in the GeV region was produced by an electron synchrotron and, by means of ferrosulfate indicators, the dose distribution was measured in a water phantom. With increasing radiation energy, depth of the water at which maximal dose was reached also increased. (H.B.G.).

41325 THE CHANCES OF GENETIC DAMAGE IN THE PROGENY OF A WOMAN TREATED WITH ^{131}I. I. CLINICAL PROBLEM AND ESTIMATION OF RADIATION DOSE TO THE GONADS. Hennemann, G.; Mellink, J. H. (Univ. Hospital, Leiden). Folia Med. Neer., 11: 40-7(1968).

Calculations of the radiation dose to the gonads and the contributions of the various radiation sources (bladder, circulating iodine, lungs, and thyroid) to that dose in the therapy of thyroid cancer in human females with ^{131}I are given. It was found that the iodine in the thyroid as a source of gonadal dose is negligible compared to other sources. The contribution of the bladder was considered unimportant compared to that of the circulating iodine. The circulating iodine amounts to 70 to 80% of the total gonad dose. Recommendations for assurance of accurate estimation of the gonad dose in an ^{131}I-treated patient are given. (C.O.)

41326 RADIATION HAZARD CONTROL SYSTEM. Kawai, Hiroshi; Honda, Yoshihide (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo, No. 6, 69-80(1967). (In Japanese).

Studies on field, laboratory, and personnel monitoring carried out during 1967 at the Atomic Energy Research Institute of Kinki University are reported. No abnormalities in leukocyte count were found following personnel monitoring of the 20 staff members. Monitoring of the laboratory and control area revealed no abnormal radioactivity. Field monitoring studies included measurement of gross β activity of natural water, plants, and fallout particles. No abnormal radioactivity was observed from experiments carried out at the institute or from nuclear weapons tests in China. Data are presented in the form of tables and figures. (NSA of Japan)

41327 PHYSICAL PROBLEMS OF ^{60}Co THERAPY USING A HYPERBARIC OXYGEN TANK. Holloway, A. F.; Campbell, E. M. (Manitoba Research Foundation, Winnipeg). pp 79-86 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Accuracy of beam direction, absorption of the primary beam by tank walls, and effect of elevated gas pressure on skin sparing with ^{60}Co γ radiation are discussed for a hyperbaric oxygen tank used with fixed field ^{60}Co radiotherapy. Optical devices were used to indicate target-skin distance and entrance and exit points of the beam axis. The light path was displaced less than 5 mm by the tank wall even with the central axis displaced as much as 7 in off the center line of the tank. The correction factor for absorption of the primary beam by the tank walls increased with increasing field size, from 0.78 for the smallest field to 0.86 for the largest field. Dose rate tables for skin surface distances of 90 and 100 cm were obtained. The effect of increased O_2 pressure on the surface ionization ratio for large fields was measured by a modified ionization chamber, with the ^{60}Co beam directed normally at a source chamber distance of 100 cm. Ionization build-up curves were obtained, and variations in surface ionization ratio with field size for O_2 pressures of 0, 15, and 30 lb/in^2. The ratios increased by about 25% for all field sizes. The tank wall increased the surface ionization ratio slightly, but the effect of pressure was small. (BBB)

41328 LITHIUM FLUORIDE DOSIMETRY UNDER HYPERBARIC CONDITIONS. Meurk, Mary Louise; Edelsack, E. A. (Mt. Zion Hospital, San Francisco). pp 87-9 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

The effect of high pressure O_2 on LiF thermoluminescent dosimeters were exposed in a Lucite-walled chamber to ^{137}Cs γ irradiation in doses of 92 to 921 R at 1 and 3 atm of O_2. The exposures recorded were essentially identical at the two pressures. Similar measurements were made with the chamber evacuated and with air at 30 lb gauge pressure. No differences were recorded in the dose. Following exposures to 400 and 1000 R of 25-MeV x irradiation from a betatron no difference in recorded exposures was observed. (BBB)

41329 DOSIMETRY. Wildermuth, Orliss (Swedish Hospital, Seattle). pp 119-26 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Advantages and disadvantages of certain irradiation techniques, hyperbaric O_2, and chemotherapy are discussed. Results of combined treatment with hyperbaric O_2 and irradiation of a tumor are reported. Use of the hyperbaric chamber permitted greater flexibility in dosimetry, and the irradiation tolerance of the tissues was more related to the number of fractions or the size of the dose in each fraction, rather than to the total elapsed time. Hyperbaric O_2 did not afford increased leeway in dosimetry, and probably only repaired a defect characteristic of the growth pattern of the tumor. It was concluded that in the presence of anoxic cell populations, hyperbaric O_2 can modify them to the same radiosensitivity as the well oxygenated population. The problems of irradiation dosage, delivery patterns of fractionation, periodicity, and total dose to be given remain even when hyperbaric O_2 is used. (BBB)

41330 IN-VIVO COUNTING OF TRANSURANIUM NUCLIDES IN THE HUMAN LUNG. Wright, C. N. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Safety, 10: 426-30(Sept.-Oct. 1969).

Analysis of feces and urine are of little value in determining the amount of an insoluble transuranium nuclide in the human lung. In vivo counting of such material is extremely difficult in that it requires the detection and measurement of low-energy x-ray photons that are easily absorbed by human tissue and bone. Both proportional and scintillation counters were used for in vivo measurements. Background-reduction techniques and extensive shielding of the counters must be used to approach the detection of 16 nCi of ^{239}Pu (or equivalent amounts of other materials). (auth)

Radiation Protection

Refer also to abstracts 41245 and 41338.

41331 (PHS-999-RH-34) GEORGIA RADIUM MANAGEMENT PROJECT. Benson, James S.; Fetz, Richard H.; Posey, Cecil D.; Robinson, Earl W. (Bureau of Radiological Health, Rockville, Md.). [1969]. 95p. Public Health Service, Rockville, Md. Free.

The Georgia Radium Management Project, a joint effort between the Radiological Health Service of the Georgia Health Department and the Radioactive Materials Section, Division of Radiological Health (presently Radioactive Materials Branch, Division of Medical Radiation Exposure, Bureau of Radiological Health), Public Health Service, determined the extent of the use of radium in medicine and the radiological health problems existing as a result of this use. Basically, the investigation concerned an assessment of: the extent and types of radium usage in the practice of medicine; adequacy of radiation safety procedures and equipment employed in handling, storing, and using radium sources; leakage of radium sources; and contamination resulting from the use of radium in medicine. Phase I of the project surveyed the hospitals of Georgia, and Phase II surveyed medical offices and clinics. Radiological health practices related to the use of radium in most of the hospitals were below acceptable standards. General and specific findings for radiological health practices in medical offices and clinics are presented. Hospitals, medical offices, and clinics were generally unaware of radium contamination insurance. A study of radium contamination insurance is included. (auth)

41332 REDUCTION OF RADON DAUGHTER CONCENTRATIONS IN MINES BY RAPID MIXING WITHOUT MAKEUP AIR. Wrenn, M. E. (New York Univ., N. Y.); Eisenbud, Merril; Costa-Ribeiro, C.; Hazle, A. J.; Siek, R. D. Health Phys., 17: 405-14(Sept. 1969).

Measurements of radon daughter concentrations and their relative states of equilibrium were made in closed sections of two uranium mines to investigate the removal of radon daughters from the atmosphere by rapid mixing. Recirculation of the air within the enclosed space once per minute reduced the working level by a factor of 20. This reduction was associated with extreme disequilibrium among the radon daughters. The lowest ratio observed between Ra-A and Ra-B was 0.06. (In this sample Ra-C was not measurable.) The mechanism involved may be convective or turbulent diffusion to the walls of the mine. Because the atmosphere sampled became extremely clean (<200 particles/cc measured with a condensation nuclei counter) the diffusion constant was probably that associated with free atoms. The state of equilibria measured indicated that removal of Ra-B and Ra-C was more efficient than that of Ra-A, probably because the Ra-B and Ra-C have longer mean lives. It appears that with adequate stirring it may be possible to remove radon daughters from mine atmospheres without the introduction of burdensomely large amounts of fresh air. These results, however, may not be applicable to atmospheres with higher particle concentrations. The results strongly suggest that further research should be made into methods of ventilation in which large amounts of makeup air are not required. (auth) (UK)

41333 ON THE PROBLEM OF THE USE OF PROTECTIVE OINTMENTS IN WORKING WITH RADIOACTIVE SUBSTANCES. Tarasenko, N. Yu.; Khodyreva, M. A. Gig. Tr. Prof. Zabol., 12: 29-33(Feb. 1968). (In Russian).

Experiments were set up to study the use of some prophylactic creams for a supplementary protection of hands in handling radioactive substances. The degree to which the skin could be cleaned from radioactive contamination served as the criterion for effectiveness. In dealing with dry substances, where no high level of contamination could be expected, biological gloves with caseine as a basis were shown to be effective in protecting the hands. All other conditions being equal, a combined protection of hands (silicon cream underneath rubber gloves) proved to ensure the cleaning of skin as many as 5 to 8 times better than the utilization of rubber gloves alone. Hence, in places presenting eventual hazards of skin contamination, for instance in doing repairs, to safeguard reliable protection of hands, as well as to preserve the normal physiological condition of the skin, it is recommended that this combined protection be used. (auth)

41334 RADIATION PROTECTION DURING X-RAY FILMING IN VETERINARY PRACTICE (PERSONAL DOSAGE MEASUREMENTS). Hartung, K.; Clauss, W.; Keller, H. (Freie Univ., Berlin). Berlin. Muenchen. Tieraerztl. Wochenschr., 81: 41-3 (Feb. 1, 1968). (In German).

Radiation burdens received by personnel engaged in veterinary roentgenography of horses were studied and evaluated. Measurements were made of x irradiation doses received by 2 technicians who held the head of the horse and a 18 × 24 cm cassette with a tube-to-focus distance of 1 m, using 58 or 68 KV x rays at 22 or 38 mA and exposure times of 0.08 and 0.04 sec. With 58-KV x rays, the cassette holder received 0.29 mR of whole-body irradiation, with 2.1 and 0.8 mR to his hands and feet, respectively. The technician who held the horse's head received doses of 0.05 and 0.1 mR of whole-body and hand irradiation, respectively. With 68-KV x rays the cassette holder received 1.75 mR of whole-body irradiation, and 2.9 and 0.8 mR to his hands and feet, respectively. The technician who held the horse's head received whole-body and hand doses of 0.45 and 1.4 mR, respectively. These values varied slightly, depending on the relative positions of the technicians and the anatomical portion of the horse that was x rayed. However, the whole-body irradiation dose did not exceed 3.4 mR in any position studied, but the hand irradiation dose was as great as 9.2 mR in some instances. Use of 0.5-mm Pb-rubber aprons and gloves decreased the whole-body and hand irradiation doses considerably. (BBB)

41335 IRREGULAR FIELD-SHAPING FOR ^{60}Co TELETHERAPY. Edland, R. W.; Hansen, Henning (Univ. of Wisconsin, Madison). Radiology, 92: 1567-9(June 1969).

An inexpensive, flexible, and rapidly executed technique of individualized secondary field-shaping for complex telecobalt fields is described. The major advantages of the method are the fidelity of daily reproduction of the original treatment plan and the correction for beam-divergence that may become a factor at intermediate source-skin distances. In addition to the usual template or mantle fields, this technique can also be readily adapted to the construction of variable-transmission step wedges for the adjunct telecobalt management of gynecologic neoplasms. (auth)

Safety Procedures

Refer also to abstract 43137.

41336 (ORNL-4423) APPLIED HEALTH PHYSICS AND SAFETY ANNUAL REPORT FOR 1968. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 82p. Dep. CFSTI.

There were no accidental releases of gaseous or liquid waste from the Laboratory that were of a reportable level as defined in AEC Manual Chapter 0524. The concentration of radioactive materials in the environs was well below the maximum levels recommended by the ICRP, FRC, and AEC. No employee received an external or internal radiation dose of a level that required a report to the AEC. The highest whole-body dose received by an employee was about 4.7 rem or 39% of the maximum permissible annual dose. There were no cases of internal exposure where the deposition of radioactive materials within the body was estimated to have averaged greater than one-half of a maximum permissible body burden. There were 20 unusual occurrences recorded during 1968, which is the second lowest number recorded since the present system of reporting unusual occurrences was established in 1960. The lowest number for any one year was 16, the number reported for 1967. The average number for the past five years was 26. The ORNL safety record for 1968 was the best in the history of the Laboratory. There was only one disabling injury reported during the year, and there was a decrease in the number of both serious injuries and medical treatment cases as compared with 1967. The disabling injury frequency rate for 1968 was 0.13, as compared with the average rate of 1.19 for the previous five years, 1963 to 1967. (auth)

41337 OCCUPATIONAL HEALTH DURING THE USE OF INDUSTRIAL GAMMA-RAY EQUIPMENT. Partolin, O. F.; Cistov, E. D. Mashinostroitel, No. 9, 38-9(Sept. 1968). (In Russian).

The Central Institute for Scientific Research on Occupational Safety in the USSR (Central Council of Soviet Trade Unions) carried out investigations on radiation safety with the most common, portable, γ-ray equipment (transportation, installation, and use). The data were used to establish safe distances and danger areas for the various instruments for which they give technical data, and for various γ sources. They also give indications regarding personal monitoring, storage of sources, and distribution of instruments. (Occup. Safety and Health Abstr.)

Civil Defense

41338 (TID-24919) RADIOLOGICAL EMERGENCY OPERATIONS. Student's Manual. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev. Radiological Sciences Dept.). [July 1968]. Contract AT(29-2)-162. 425p. Dep. CFSTI.

This Students' Manual provides guidance and information for the student attending the ten-day Radiological Emergency Operations course. It includes the schedule of classes, a list of publications recommended as texts for the course, information on where to obtain the recommended texts, a bibliography of references, movie films used in this course, a brief outline of the subject matter covered in each lesson, study questions and answers on the main points in each lesson, and technical reference information pertinent to the subjects covered. Section 4 contains a chapter on each of the twenty-two subjects covered in the lessons outlined in Section 1. These chapters are not substitutes for the material covered in class. They should, however, be useful for review and study purposes in addition to the reading assigned by the instructor. (auth)

Legal Aspects

41339 LEGISLATIVE AND REGULATORY ACTIVITIES. Nucl. Law Bull., No. 3, 4-21(Apr. 1969).

Legislative and regulatory activities in relation to radiation protection of man, processing and handling of radiation sources, patents, organization and structure of administrative authorities, and regime of nuclear installations are briefly reviewed. The countries discussed are Austria, Denmark, France, Germany, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. (C.O.)

41340 CASE LAW AND ADMINISTRATIVE DECISIONS. Nucl. Law Bull., No. 3, 22-7(Apr. 1969).

Case law and administrative decisions in Belgium were summarized in relation to criminal liability arising from accidental irradiation which in turn led to the question of civil liability. In France, decisions related to compensation for workers suffering from occupational diseases attributable to ionizing radiation are summarized. (C.O.)

41341 INTERNATIONAL ORGANIZATIONS AND AGREEMENTS. Nucl. Law Bull., No. 3, 28-34(Apr. 1969).

Rules and regulations pertaining to the composition of the board of governors of the IAEA are reviewed; a safeguards transfer agreement and safety standards are summarized; studies on radioactivity in the sea are outlined and proposed; privileges and immunities of the IAEA are discussed; and legislative assistance tendered to non-member countries by the IAEA are listed. Within the European Nuclear Energy Agency (ENEA), the technical scope of application on nuclear third party liability is discussed. Brief summaries are presented of agreements concerned with peaceful uses of atomic energy between EAEC and the United Kingdom, the carriage of nuclear substances in France, and the use of Dutch coastal waters and ports by German nuclear powered research ships, and third party liability of operators of nuclear ships in the Netherlands. (C.O.)

Medicine

Refer also to abstracts 40580, 41331, and 41473.

41342 (TT-69-50007/2) POLISH MEDICAL JOURNAL, VOL. 8, NO. 2, 1969. Translated for National Library of Medicine, Washington, D. C., from selected Polish medical publications. 268p. CFSTI.

Separate abstracts were prepared on three articles. Other articles report results of various physiological studies. (C. H.)

For abstracts of individual papers see: 41219, 41402, and 41489.

41343 STUDIES ON STERILIZATION OF SURGICAL SUTURE BY γ RAY. 1. RADIATION EFFECTS ON PHYSICAL PROPERTIES OF SURGICAL SUTURE. Horibe, Takashi; Kikuchi, Hiroshi (National Inst. of Hygienic Sciences, Tokyo). Eisei Shinkenjo Hokoku, No. 86, 41-4(Dec. 1968). (In Japanese).

The physical properties (tensile strength on straight pull, on surgeon's knot, and elongation) of the absorbable and non-absorbable surgical sutures, which were irradiated by γ radiation from ^{60}Co source at 4 levels (0, 0.5, 1.0, 2.5 Mega roentgen) for the purpose of sterilization, were investigated. Tensile strength and elongation of absorbable suture (cat gut) and non-absorbable suture (silk, polyester, nylon) were little or not influenced by irradiation. Non-absorbable surgical suture (tetrafluorethylen, polypropylen) showed decrease of tensile strength and elongation by irradiation at 0.5 mega roentgen. (NSA of Japan)

Protective Substances

Refer also to abstracts 41202, 41246, 41409, 41446, 41449, 41458, and 41497.

41344 (AD-688374) RADIOPROTECTION OF RODENTS WITH PAPAIN. Report for September 1967-September 1968. Hamilton, Horace E.; Melville, George S. Jr.; Moss, Shirley A. (School of Aerospace Medicine, Brooks AFB, Tex.). Mar. 1969. 14p. (SAM-TR-69-15). CFSTI.

The proteolytic enzyme papain was demonstrated to be moderately radioprotective in rats. The enzyme was administered intraperitoneally both activated and nonactivated in water, in a water-dimethyl sulfoxide solvent system. Greater survival was achieved with the activated form in the H_2O-DMSO solvent; administered by this method thirty minutes prior to 1200 R γ radiation delivered at a dose rate of 400 R/minute, 50% survival was obtained at a papain dose of 43.2 milligrams per kilogram rodent weight. The optimum time of injection was found to be in the interval 10 to 20 minutes prior to irradiation. Administered in water, the enzyme induced an initial radiation-sensitizing effect, but this was not noted when the dimethyl sulfoxide was utilized. (TAB)

41345 (AD-688501) RADIOPROTECTION: ANTIRADIATION AGENT DEVELOPMENT AND CHEMICAL RADIOPROTECTION RESEARCH AT THE SCHOOL OF AEROSPACE MEDICINE. Melville, George S. Jr. (School of Aerospace Medicine, Brooks AFB, Tex.). Feb. 1969. 18p. (SAM-Review-1-69; SAM-TR-69-8). CFSTI.

The Radiobiology Division of the USAF School of Aerospace Medicine was actively engaged for over a decade in research designed to favorably modify the injury resulting from exposure to ionizing radiation. The program developed concepts, technics, drugs, and scientific data that described the effects, mechanisms, and clinical manifestations of both the radiations used and the drugs chosen to combat the effects. The program was reviewed in terms of history, concepts, progress, and what the future may offer. (TAB)

41346 (AD-688692) INVESTIGATION OF MATERIALS AND SYSTEMS FOR PROTECTION AGAINST FLASHBLINDNESS EFFECTS OF NUCLEAR DETONATIONS. Final Report, June 1, 1963-May 1, 1964 on Phase I. Dreyer, John F.; Harries, Robert W.; Macnair, Richard N.; Feldman, David (Polacoat Inc., Blue Ash, Ohio). Feb. 1968. Contract DA-19-129-AMC-112(N). 149p. CFSTI.

The initial phase of a research effort to develop an ophthalmic protective device for use against flashblindness resulting from nuclear detonations is outlined. Efforts to develop a sensitive and relatively transparent photothermosensitive material, that can be prepared as a thin film and can become a filter having high optical density upon exposure to intense electromagnetic radiation, are described. Several materials were prepared that possessed satisfactory spectral absorption characteristics and were suitable for application to nuclear flashblindness protection. The synthesized compounds were members of the triphenylmethane, azo, and polymethine dye classes. The formulation of these materials as photochromic thin film filters produced systems that became colored in less than 40 nanoseconds and reached an optical density of 3.8 in 100 microseconds, measured at the wavelength of the absorption maxima. The films prepared had an initial transmittance of 70 to 80%. The problem of storage stability of the photothermosensitive materials at −65F to +125F for periods of at least 6 months was not solved. The feasibility of a two-component system that combines the two components and activates the system just prior to use was established. (TAB)

41347 THE EFFECT OF THE CALCIUM AND FLUORINE CONTENT OF THE FOOD RATION ON THE RADIORESISTANCE OF ANIMALS TO COMBINED INJURY DUE TO EXTERNAL GAMMA IRRADIATION AND INCORPORATED ^{90}Sr. Knizhnikov, V. A.; Grozovskaya, V. A. Vop. Pitan., 27: 33-6(July-Aug. 1968). (In Russian).

Male rats were given a food ration containing different amounts of calcium and fluorine for a long time. Two months after a whole-body gamma-irradiation in doses of 350 to 700 R the animals of all groups were subjected to peroral poisoning with strontium-90. The rats kept on a diet with elevated calcium and fluorine content, especially when both of these elements had been added to the food, lived for a much longer time than did control animals which had been receiving a ration with an ordinary content of calcium and fluorine. (auth)

41348 EFFECT OF VITAMIN E ON FETAL MALFORMATION AND PLACENTAL INJURY INDUCED BY γ RAY IRRADIATION OF ^{60}Co. Matsuura, Hideyuki (Iwate Medical Univ., Morioka, Japan). Bitamin, 39: 251-61(Apr. 1969). (In Japanese).

Mice were divided into three groups: first group was untreated, and the other two groups were irradiated with 200 R of γ-rays of ^{60}Co on the 10th day of pregnancy. The third group was divided into three sub-groups which were treated intramuscularly with 0.2, 1.0, 5.0 mg/day of vitamin E, respectively. Half of each group was treated from the 1st to 19th day and the other half was given the same doses of vitamin E after radiation from 10th to 19th day. The author has confirmed the fact that the proper dosage of vitamin E could reduce mortality and incidence of malformation of the fetus and reduce the radiation injury of the placenta. The most effective result was obtained by the administration of 1.0 mg/day from the beginning of pregnancy. (NSA of Japan)

41349 MINIMUM DOSE OF X RAYS ABLE TO ALTER IN VIVO INTESTINAL ABSORPTION OF GLUCOSE. Lluch, M.; Ponz, F. (Univ. of Navarra, Pamplona, Spain). Rev. Espan. Fisiol., 24: 117-19(Sept. 1968).

The effect of x radiation on the rat intestinal absorption of glucose and the radioprotective action of cysteamine was demonstrated. After irradiation with 600 R the absorption diminished initially (at 2 to 8 hr), then increased (at 24 hr), and finally showed a progressive falling off up to the end of the experiment (at 96 hr). The minimum dose of x rays necessary to affect the intestinal glucose absorption was determined. The absorption was observed at 8, 24, and 96 hr following various doses of irradiation in rats. The glucose concentration was 2.77 mM, resulting in a flux toward the blood in active transport conditions. A 50-R dose did not affect glucose absorption during the experimental period. An increase to 100 R produced no significant change at 8 and 24 hr, but at 96 hr there was a definite increase in the active transport of glucose of about 45%. The results at 600 R are also shown. The increase in glucose absorption at 96 hr after 100 R was eliminated by the injection of cysteamine before irradiation. This confirmed the radioprotective capacity of cysteamine with respect to changes in intestinal absorption already observed with larger doses, and demonstrated that the increase in absorption was due to effects of irradiation. (BBB)

41350 COLONY-FORMING CELLS IN IRRADIATED, PARTIALLY SHIELDED, ENDOTOXIN-TREATED MICE. Gidali, Julia; Feher, Imre; Gallyas, Alfreda; Varteresz, Vilmos (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Radiat. Res., 39: 305-16(Aug. 1969).

The kinetics of the regeneration of colony-forming units (CFU) were studied in endotoxin-treated or nontreated, one-leg-shielded mice at 30 minutes, 6 hours, and 3, 7, and 10 days after irradiation with 500 R. Eight micrograms of Serratia marcescens endotoxin given 20 minutes after irradiation was found to significantly influence CFU regeneration kinetics. As compared to the whole-body-irradiated animals, CFU regeneration was accelerated in the partially shielded ones; 10 days after irradiation the CFU reached 59% of the control value in the exposed tibia of the partially shielded animals, as against the 35% measured in the whole-body-irradiated ones. A significant CFU decrease in the shielded tibia was measured at 30 minutes after irradiation and was presumably a consequence of the so-called abscopal effect. CFU regeneration kinetics changed in a characteristic way in the exposed tibia of the endotoxin-treated animals: Abortive regeneration failed to occur at the sixth hour; the CFU level was appreciably higher in the endotoxin-treated animals in the initial phase of regeneration; and the 10-day value was appreciably lower as compared to that found for the irradiated control animals. Reduced CFU level was measured in the shielded tibia of the endotoxin-treated mice during the whole experimental period. (auth)

41351 PROTECTION OF NEONATES AGAINST WHOLE-BODY RADIATION BY THE ADMINISTRATION OF A SINGLE EMULSIFIED INJECTION OF A LIPOPOLYSACCHARIDE DURING PREGNANCY. Prigal, Samuel J. (Flower-Fifth Avenue Hospital, New York). Proc. Soc. Exp. Biol. Med., 131: 159-63(May 1969).

A lipopolysaccharide (LPS) derived from E. coli was administered to mice during gestation yielding neonates that were highly resistant to lethal whole-body radiation. The LPS was given as an emulsion in mineral oil: the slow release from the emulsion eliminated the abortive and toxic effect of the LPS and prolonged its effective action. (auth)

41352 CLINICAL TRIAL WITH ATMOSPHERIC OXYGEN BREATHING DURING RADIOTHERAPY OF CANCER OF THE CERVIX. Bergsjoe, P.; Kolstad, P. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 167-71(1968).

Effects of oxygen inhalation at atmospheric pressure on radio-response of cervical cancer was studied in 102 patients along with 106 air-breathing controls. Therapy consisted of a combination of intracavitary Ra treatment and external fractionated irradiation to pelvic fields. X rays delivered by 31- or 33-MeV betatron machines were used for doses of 200 R per fraction, the maximum measured dose being 5000 R, and with central shielding of 2500 R. Oxygen was administered through an ordinary anesthesia face mask starting 5 to 10 min before the betatron irradiation and continuing throughout the whole treatment, which lasted for 10 min. During radium treatment the patients breathed through the face mask for 15 min every hour during daytime. In this way the patients received oxygen for a total of 10 to 15 hr during each application. The vascularization of the tumor was studied by colpophotography, and the tumor oxygen tension before and during therapy was measured by polarography. At 1- to 3-yr follow-up examinations, local recurrence in the pelvis was detected in 35 of the 106 control cases. In 33.1% the tumor was not sterilized by the radiation dose applied. The corresponding figures for the oxygen inhalation groups were 30.1% and 22.4% respectively (Ra and Ra + x rays). The best result was obtained when oxygen was administered both during Ra applications and external irradiation. The crude survival of the control series was 59.4% as compared to 62.3% and 67.3% for the 2 oxygen series. These differences, however, are not statistically significant. (BBB)

41353 ALTERED SPLIT-DOSE RECOVERY IN MICE IRRADIATED UNDER HYPOXIC CONDITIONS. Phillips, Theodore L.; Ainsworth, E. John (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 39: 317-31(Aug. 1969).

Mice were protected from radiation injury by exposure to an atmosphere of 5% oxygen during irradiation, and a dose-modifying factor (DMF) of 2.03 was obtained. A significant difference in the split-dose recovery patterns was noted after conditioning doses under hypoxia and air conditions. This was confirmed when an hypoxic conditioning dose was followed by redetermination of the $LD_{50(30)}$ in air. Comparison of these patterns leads to the conclusion that early repair at the cellular level is diminished after irradiation under hypoxic conditions in the particular cell type responsible for death of the mouse. Multiple exposure data and calculated dose-modifying factors for the split-dose situation indicate that a maximum reduction in the DMF from 2.03 to 1.53 can be attained. This reduction in DMF with multiple exposures has significance for radiation therapy, since it indicates that fractionated radiation therapy may obviate some of the problems encountered when a portion of a tumor is hypoxic. (auth)

41354 LOCAL RADIATION PROTECTION. Lancet, 1: 1039-40(May 24, 1969).

Use of radioprotective agents to diminish local radiation effects is briefly reviewed. The postirradiation erythema of the rat tail after x irradiation can be decreased by the application of 10% cysteine in petroleum jelly before irradiation. Also, 1% and 5% cysteamine in jelly, or 10% aqueous solutions of cysteamine, protected rabbit skin against ulcerating doses of x irradiation. Mice exposed to 1400- to 1800-R head irradiation died 18 days after irradiation with a characteristic ulceration of the dorsal surface of the tongue, which prevented them from eating. When saturated solutions of cysteamine or AET were applied to the tongue before irradiation, 18-day mortality was decreased. Soaking the limbs of rats in 10% dimethylsulfoxide (DMSO) before localized x irradiation has been shown to decrease postirradiation epilation. Again this effect seems to be a local protection. Both DMSO and glycerol have also been shown to protect mouse tail bones, irradiated in vitro before transplantation to the kidney capsule of syngeneic hosts. From diverse animals studied, the overall impression is that there may be a place in radiotherapy for topical protection of normal tissues surrounding superficial tumors. (BBB)

41355 ROLE OF THE PHAGOCYTE IN HOST-PARASITE INTERACTIONS. XVI. EFFECT OF X IRRADIATION ON H_2O_2 PRODUCTION IN GUINEA PIG EXUDATE CELLS. Paul, Benoy; Strauss, Robert; Sbarra, Anthony J. (St. Margaret's Hospital, Boston). RES. J. Reticuloendothel. Soc., 5: 538–49(Dec. 1968).

Phagocytes isolated from x-irradiated animals are relatively inefficient in bactericidal activity during certain postirradiation periods. The hexose monophosphate shunt (HMS) activity in these phagocytes is also decreased. A study was designed to relate the H_2O_2 level, HMS activity, and bactericidal activities of phagocytes isolated from x-irradiated animals that might further reveal the role of H_2O_2 in intracellular killing in the phagocyte and provide information relative to the irradiation effect. The total hydrogen peroxide content of phagocytizing polymorphonuclear leukocytes (PMN) isolated from normal guinea pigs was significantly higher than that of nonphagocytizing cells, due to a 2- to 4-fold increase in H_2O_2 production by phagocytizing cells. PMN isolated from 100-R whole-body x-irradiated guinea pigs were altered with respect to their H_2O_2 and bactericidal activities. Three to 5 days postirradiation these PMN showed decreased bactericidal activity, and addition of particles did not increase H_2O_2 production over that observed for resting cells. Depression in the phagocytosis-associated oxidative metabolism, especially the HMS, appears to interfere with the production of H_2O_2. However, the total H_2O_2 levels of PMN from x-irradiated guinea pigs were higher than that of PMN from normal guinea pigs. Particle-associated metabolic H_2O_2 rather than the total H_2O_2 seems to be specifically related to bactericidal activity. (BBB)

41356 REOXYGENATION OF TUMORS AFTER IRRADIATION AND CELL POPULATION KINETICS. Begg, A. C.; Denekamp, J.; Howes, A. E. (Hammersmith Hospital, London). J. Physiol. (London), 200: 16P–17P(May 1969).

After irradiation of some tumors, the mean oxygen content of the surviving cells may increase, making the tumor more sensitive to further irradiation. This increase of oxygen content (reoxygenation) is an important factor in determining whether a tumor can be cured by radiotherapy. Studies were made of the extent and time course of these changes in first generation transplants of spontaneous mammary carcinoma in C_3H mice. In this tumor a large radiation effect is seen within a few hours, the proportion of hypoxic cells falling from 100% just after 1500 rad of x rays to about 1% at 48 to 72 hr later. This result is relevant to fractionation intervals in radiotherapy. The cell population kinetics of this mouse carcinoma and of three rat sarcomas were investigated using tritiated-thymidine autoradiography. They included tumors with volume doubling times of 1, 1.5, 3.5, and 5 days. The mouse carcinoma was the only one showing a large proportion (70%) of its cells lost per population doubling time. This finding correlated both with the rapid shrinking observed after a dose of x rays, and with the large extent of reoxygenation measured in this tumor. (BBB)

41357 INCREASED RADIOSENSITIVITY OF SKIN IN HUMANS IRRADIATED IN 4 ATA OXYGEN PRESSURE. Van Den Brenk, H. A. S. (Cancer Inst. Board, Melbourne). pp 141–8 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158–(Vol.1).

Effects of air and hyperbaric O_2 at 45 psi on human skin were compared when single doses of 250 to 1250 R of ^{90}Sr β irradiation were used. Skin reactions in O_2 were more severe at all dose levels. Dose-effect curves were constructed. The residual skin reaction remained almost constant for 20 to 100 days after irradiation. Reactions were dose dependent, and as the dose increased the O_2 enhancement effect increased. In the dose range from 250 to 750 R the equivalent isodose in air was $\sim 33\%$ higher than the O_2 dose and $\sim 50\%$ higher for 1250 R. When x-ray doses of 3×1000 R and 6×600 R were delivered over 3 weeks, tissue necrosis was likely. Myelopathy and brain necrosis were observed after full dosage of the cervical cord, brain stem, or cerebral cortex. Similar injuries were observed after 3×1000 R and 6000 R delivered in 5 weeks in air. Dose increments in O_2 differed by $\sim 20\%$ from those in air. Biologically effective doses in O_2 and in air were related to parameters of cell survival and are tabulated. (BBB)

41358 GYNECOLOGICAL CANCER TREATED WITH COBALT UNDER HYPERBARIC CONDITIONS. Johnson, R. J. R. (Manitoba Research Foundation, Winnipeg). pp 149–55 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158–(Vol.1).

The results of cobalt-60 γ radiation treatment of gynecological cancer before and after the acquisition and use of a Vickers hyperbaric chamber are reported. Only 20% of stage III and IV cervical carcinoma cases were alive and tumor-free in six months, and 32% survived for three years in the radiotherapy without hyperbaric oxygen (control) group. Forty-five per cent of the hyperbaric oxygen group were alive and free of local tumor at 6 months; 30% were dead at 6 months compared to 15% of the control group. Doses of 6500 rads given in hyperbaric conditions in six weeks failed to control 55% of the primary disease. Individual tumor sensitivity and density were considered relevant factors. A high death rate (25%) in the first six months following hyperbaric treatment from distant metastases is discussed. Palliation for patients surviving the first six months was considered excellent. The treatment method, field alignment, and complications observed are detailed. (C.O.)

41359 EFFECT OF PRE-IRRADIATION ON THE RATIO OF OXYGENATED AND ANOXIC CELLS IN A TRANSPLANTED MOUSE TUMOR. Van Putten, L. M.; Kallman, R. F. (Stanford Univ., Palo Alto, Calif.). pp 27–37 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158–(Vol.1).

The relative effects of fractionated and acute irradiation on oxygenated and anoxic foci of a mouse sarcoma are reported. Tumor cells x irradiated in vitro with doses of up to 3000 R in the presence of O_2 survived exponentially, but cells irradiated in the presence of N_2 were much less sensitive. Survival curves of tumors irradiated in air-breathing and in dead mice had essentially similar terminal slopes, but different O_2 dose extrapolates. In the air-breathing mice $\sim 15\%$ of the tumor cells were anoxic. Following localized irradiations of 200 R for 5 days and administration of O_2, $\sim 19\%$ of the tumor cells were anoxic. The lack of large increase in anoxic cells indicated changes in the relation between tumor cell parenchyma and its vascular stroma, and increased radiosensitivity of the tumor after preirradiation and O_2 administration. (BBB)

41360 EFFECT OF ANOXIA ON RADIATION INJURY AND RECOVERY. Phillips, T. L.; Hanks, G. E. (Univ. of California, San Francisco). pp 38–45 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158–(Vol.1).

The possibility that anoxia reduces the effect of the linear energy transfer (LET) of a radiation beam, shifting its indirect damage to direct damage and causing the nonlethal damage to be irreparable was studied. The Laf_1 mouse $LD_{50(30)}$ values in air and hypoxia were 846 and 1719 R with mean survival times of ~ 13 and 8 days, respectively. Recovery patterns differed after a $\frac{2}{3}$ LD_{50} dose was given in air or anoxia. In air a rapidly decreasing injury remained at days 1 and 3. In anoxic animals no recovery occurred on day 1 and only 7% on day 3. No difference in survival time was found after day 3. After split irradiation doses the protection ratio fell from 2.03 for a single dose to 1.53 for 2 doses at a 3-day interval. At 11 days the ratio was 2.05. No differences in bone marrow damage were found in mice in air or hypoxia. By use of the endogenous spleen nodule technique, D_0 values were 115 and 265 R for air and hypoxia, respectively. Nodule values and recovery were lower in hypoxic animals than in animals irradiated in air. (BBB)

41361 ATMOSPHERIC VERSUS HYPERBARIC OXYGEN BREATHING IN RADIOTHERAPY. Rubin, P. (Strong Memorial Hospital, Rochester, N. Y.). pp 46–70 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158–(Vol.1).

The theoretical concepts and practical implications of O_2 breathing and concentrations of dissolved O_2 in biologic systems at the time of irradiation and relations to radiosensitivity are reviewed. The rationale for hyperbaric O_2 breathing as based on oxygenation of tissues and radiosensitivity, the concept of a cancer cord consisting of a collection of epithelial cells surrounded by a vascular stroma without penetrating capillaries between cells, clinical O_2 probe studies, and results of animal tumor experiments are itemized. The rationale for atmospheric O_2 breathing, derived from studies of oxygenation and radiosensitivity, advantages of small fractional irradiation doses over single large doses for destruction of cancer cords and improved oxygenation of tumor cells, measurement of O_2 tissue tension in regressing irradiated tumors, and tumor experiments in animals are discussed briefly. Fractionation schedules and clinical experiences with atmospheric O_2 breathing are reviewed, the advantages and disadvantages of atmospheric vs hyperbaric O_2 breathing are compared, and an integrated plan for their use is presented. (BBB)

Radiation Sickness and Injuries

Refer also to abstract 41466.

41362 EFFECT OF VITAMIN E ON THE γ IRRADIATED MOUSE PLACENTA. HISTOLOGICAL OBSERVATIONS. Matsuura, Hideyuki (Iwate Medical Univ., Morioka, Japan). Bitamin, 39: 262-6(Apr. 1969). (In Japanese).

Pregnant mice were irradiated by 200 R of γ-rays of ^{60}Co on the 10th day of pregnancy and were administered continuously 1.0 mg/day of vitamin E from the 1st day of pregnancy. Histological findings of the placenta of irradiated mice with vitamin E administration were investigated every two or three days in succession, comparing with those of control animals. In general, the irradiated placenta showed underdevelopment, degeneration and circulatory damage in its every layer and these changes were most manifest on the 4th day after irradiation. From the 6th day on these changes were gradually improved. The radiation injury of the placenta was reduced to some extent by the administration of vitamin E and its effect was noticed from the 2nd day after irradiation. (NSA of Japan)

41363 OPERATIVE TREATMENT OF URETERAL LESIONS ASSOCIATED WITH GYNECOLOGICAL OPERATIONS AND RADIOTHERAPY. Railo, J. E.; Widholm, O.; Tenhunen, A.; Timonen, S. (Univ. Central Hospital, Helsinki). Ann. Chir. Gynaecol. Fenn., 57: 119-27(1968).

Forty cases of ureteral injury, half of them as a result of irradiation, are reported and their management is described. Postoperative lesions developed within about 1 to 2 months after radiotherapy, and the finding then consisted of a fistula or beginning of a more advanced hydronephrosis. The corrective operations employed included liberation of the ureter, implantation, Boari's plastic operation, partial replacement of the ureter with small bowel, and, if none of these methods was feasible because of extent of the damage or local conditions, the entire urinary bladder was replaced by cecum, which makes a good substitute for bladder. It was important not to try to use irradiated tissues for repair. In strictures and fistulae which have developed after operation, even in irradiated cases, simple implantation seems to lead to good results, provided that it can be done easily and completely without stretching. If the damage is at a higher level, cystoureteroplasty according to Boari can be done using a tongue-shaped piece of tissue separated from the bladder wall if the bladder has not been irradiated. In case of additional radioinduced lesions in the bladder, adjoining the intestinal transplant to the irradiated neck of the bladder does not succeed, but in these cases it is best to replace the entire bladder and lower parts of the ureters with intestine (ileum, cecum, or sigmoid). (BBB) (TSS)

41364 THE MANAGEMENT OF SOFT TISSUE BEFORE, DURING, AND AFTER TREATMENT FOR ORAL CANCER. Edgerton, Milton T.; Hoopes, John E.; Marchetta, Frank C.; Powers, William E.; Gaisford, John C.; Frazell, Edgar L.; McKee, Duncan. CA - Cancer J. Clin., 19: 40-52(Jan.-Feb. 1969).

Postirradiation care of oral tissues is reviewed after a description of various types of radiation injury to these tissues. The limits of tolerance to irradiation are not a simple function of dose, but are complexly related to total dose, time over which dose is given, number of treatment sessions, volume and type of tissue irradiated, and type of equipment used. Protection of certain structures is achieved by reducing the dose administered to them or by suitable fractionation of the treatment so as to preserve a sufficient number of normal cells and thus prevent permanent disability to the necessarily irradiated soft tissues. Partial protection is often pospossible and is best accomplished by proper selection of the method of treatment (interstitial treatment, x rays, electrons, γ rays) and by proper beam direction to reduce the dose to the normal tissue surrounding the lesion. Protraction and fractionation of the radiation make possible the repopulation and healing of the necessarily irradiated soft tissues. The irradiated soft tissues are not normal and are much more sensitive to any subsequent trauma. Patients should continue adequate oral hygiene during the acute radiation reaction because the exposed submucosa is easily damaged by infection. (BBB) (TSS)

Radiodiagnosis

Refer also to abstracts 41024, 41030, 41190, 41191, 41203, 41464, 41466, 41476, and 41477.

41365 (CONF-670338, pp 299-314) PUERTO RICO NUCLEAR CENTER. Gomberg, Henry J. (Puerto Rico Nuclear Center, Mayaguez).

The Puerto Rico Nuclear Center was created in 1955, at the time of the first Geneva Conference on Peaceful Uses of Atomic Energy. President Eisenhower authorized the United States Atomic Energy Commission to establish a nuclear center for the purpose of encouraging development of peaceful uses of nuclear energy in Latin America. The Center is operated for the U. S. Atomic Energy Commission by the University of Puerto Rico. Its nuclear programs are distributed throughout the island, with concentrations at the university branches at San Juan and Mayaguez. Some of the research activities of the Center are: nuclear medicine, nuclear science and engineering, radiobiology, terrestrial and marine ecology, radioinduced mutations in sugar cane, hot atom chemistry, and food preservation. (auth)

41366 PROGRESS IN HEMATOLOGY. VOLUME VI. Brown, Elmer B.; Moore, Carl V. (eds.). New York, Grune and Stratton, Inc., 1969. 396p. $19.75.

Separate abstracts were prepared for two chapters of the book. Eight other chapters are included on hemolytic anemias, the treatment of hemophilia, thrombosis, hemoglobin synthesis, and clinical usefulness of iron chelating agents. A subject index is included. (H.L.W.)

For abstracts of individual chapters see: 41262 and 41368.

41367 CINQUIEME SESSION DE LA SOCIETE EUROPEENNE DE RADIOLOGIE PEDIATRIQUE, HAMBOURG, 16-17-18 MAI 1968. (Fifth Session of the European Society of Pediatric Radiology, Hamburg, May 16-17-18, 1968). Ann. Radiol., 12: R139-440(1969). (In French and English). (CONF-680552).

A separate abstract was prepared for one of the 33 papers presented in this symposium. The other 32 papers discuss diseases of the digestive system, genitourinary system, cardiovascular system, skeletal system, nervous system, and various radiographic techniques. The papers are presented in French and English. (E.R.B.)

For an abstract of the individual paper see: 41470.

41368 NEWER TRACER TECHNIQUES IN HEMATOLOGY. McIntyre, Patricia A.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Progr. Hematol., 6: 305-37 (1969).

Factors to be considered in the selection of radiopharmaceuticals are biologic behavior, type and rate of radioactive decay, detection characteristics, and production factors. The use of ^{52}Fe for bone marrow scans, and the use of ^{198}Au, ^{113}In, and ^{99}Tc in colloidal preparations for visualization of the reticuloendothelial system in bone marrow are described. A ^{99}Mo—^{99}Tc generator to produce ^{99}Tc-sodium pertechnetate is described. Methods are discussed for the use of damaged erythrocytes labeled with ^{51}Cr and ^{197}Hg-mercurihydroxypropane as spleen scanning agents. Colloids labeled with ^{113}In or ^{99}Tc are also used for spleen scanning. Studies on sequestration of ^{51}Cr-labeled platelets in the liver and spleen were conducted for selecting thrombocytopenic patients for splenectomy. External counting was used to demonstrate unusual lung and spleen sequestration of ^{51}Cr-labeled leukocytes with subsequent release of activity in patients with chronic myelocytic leukemia. A method of measuring blood loss from the gastrointestinal tract or uterus using ^{51}Cr-labeled erythrocytes is discussed. Absorption of ingested vitamin B_{12} was measured using whole-body counting techniques following oral administration of cyanocobalamin labeled with ^{58}Co or ^{60}Co. (H.L.W.)

41369 INVESTIGATION AND TREATMENT OF METASTATIC THYROID CARCINOMA WITH RADIOIODINE. Andrews, John T.; Minty, Cyril C. J. (Cancer Inst., Melbourne). Clin. Radiol., 20: 237-9(Apr. 1969).

A survey was made of all patients with metastatic cancer referred for radioiodine diagnosis and therapy at the Cancer Institute, Melbourne, between 1955 and 1965. Iodine-131 was used in all cases and a manual scan made 24 hours later—using a single hole collimator. Scans were made on 98 patients with metastases and 67 of these had carcinoma of the thyroid: 17 patients had an uptake of radioiodine in the metastases, of which 14 were treated with therapeutic doses. The diagnostic and therapeutic uses of radioiodine are discussed and methods of improving the results indicated. Nine patients benefitted from treatment with I-131 and two patients with pulmonary metastases appeared to be cured. (auth)

41370 VALUE OF ^{18}F FOR SCANNING BONE TUMOURS. Harmer, C. L.; Burns, J. E.; Sams, Alice; Spittle, Margaret (Westminister Hospital, London). Clin. Radiol., 20: 204-12 (Apr. 1969).

The mechanisms of uptake of fluorine and strontium by normal as well as abnormal bone are described and the advantages of fluorine for scanning are emphasized. The scanning technique is discussed and a method for accurate reduction in size of the radiographic image to correspond exactly with that of the scan image is described. Attempts to increase fluorine-18 uptake by regional hydrogen peroxide infusion were unsuccessful. The great value of scanning primary tumors of bone lies in the early detection of recurrent disease following treatment by irradiation. The value of scanning secondary tumors in bone lies in the early detection of metastatic disease in the presence of a normal radiograph. Benign conditions of bone liable to cause difficulty in interpretation are illustrated. (auth)

41371 THE USE OF PULMONARY RADIOISOTOPE SCANNING AND BRONCHOSPIROMETRY TO ASSESS DISTURBANCES IN VENTILATION AND PERFUSION OF THE LUNGS. **Herzog, H.; Fridrich, R.; Baumann, H. R.; Endrei, E. Respiration, 26: Suppl., 204-18(1969).**

Radioisotope methods were employed for distribution analysis of ventilation and perfusion in pulmonary tissue in the diagnosis of pulmonary disease. In a method of combined radioisotope scanning, lung perfusion was visualized by intravenous injection of human serum albumin labeled with ^{131}I and ventilation by inhalation of colloidally dispersed ^{198}Au or ^{99m}Tc-labeled albumin with the aid of a pressure-cycled respirator. In the perfusion scan after first carrying out thyroid blockade with Lugol's solution, the scan was made immediately following the injection of 300 μCi of heat-denatured, macroaggregated ^{131}I-serum albumin. The amount of albumin injected was 2 to 8 mg, with a colloidal size of between 5 and 50 μ. The distribution of activity was recorded from the base of the lung to the apex by means of a color- and photo-scan (pulse yield of 9000 to 18,000 cpm). The ventilation scan was recorded 24 hr following the administration of 300 to 500 μCi of colloidal ^{198}Au or by the use of ^{99m}Tc-albumin. The inspiration pressure was 15 cm H_2O, and the inspiratory flow was adjusted to the visco-elastic properties of the patient's lungs. The radioactively contaminated expiratory air was removed with a slight negative pressure. After an interval of at least 1 to 2 hr during which the interfering radioactivity in the trachea and large bronchi had mostly disappeared due to ciliary action, the scintigrams were recorded. (BBB)

41372 SCINTILLATION CAMERA SCANNING OF THE SALIVARY GLANDS. **Soradahl, Oliver A.; Williams, Clyde M.; Bruno, Fred P. (Univ. of Florida, Gainesville. Veterans Administration Hospital, Gainesville, Fla.). Radiology, 92: 1477-80(June 1969).**

Technetium-99m-pertechnetate injected intravenously is rapidly accumulated by the salivary-gland parenchymal cells and then discharged into the oral cavity. Multiple views of these rapidly changing patterns of radioactivity can be obtained with a 10 mCi dose of ^{99m}Tc and an Anger scintillation camera. In addition to the recording of normal dynamic physiological changes in the salivary glands in some 90 cases, it was possible to demonstrate pathological changes in function such as obstruction by a calculus, anatomic displacement in adjacent tumor masses, and pathological replacement of normal salivary gland tissue by tumor. (auth)

41373 RETROSPECTIVE EVALUATION OF ISOTOPE IMAGES OF THE BRAIN IN 852 PATIENTS. **Gold, Lawrence H. A.; Loken, Merle K. (Univ. of Minnesota Hospitals, Minneapolis). Radiology, 92: 1473-6(June 1969).**

The greatest value of the isotope image of the brain lies in its value as a screening test for intracranial pathology. These studies are easy to perform with little or no patient discomfort. There is no morbidity or mortality associated with the procedure, and radiation exposure to the patient is negligible with the use of ^{99m}Tc. Furthermore, the diagnostic yield is high with essentially no false positive results and few false negative results. The pattern of abnormal isotope images is frequently nonspecific and tumor often cannot be distinguished from infarct. Still, a positive scan is an indication for the clinician to proceed with further diagnostic intracranial examinations. (auth)

41374 ^{99m}Tc JOINT IMAGES. **Maxfield, William S.; Weiss, Thomas E. (Louisiana State Univ., New Orleans. Ochsner Clinic, New Orleans). Radiology, 92: 1461-6(June 1969).**

Technetium-99m joint images are useful for early detection of synovitis and documentation of the pattern of synovitis for various types of arthritic processes. The scintillation study of the joints can also be used to document the course of the disease and the response or failure of various types of treatment. The ability to evaluate the joints of the extremities within the period of thirty minutes to one hour with ^{99m}Tc-pertechnetate and a stationary imaging device with a low radiation dose makes ^{99m}Tc joint studies a clinically useful procedure. (auth)

41375 RADIOACTIVE ALBUMIN MICROSPHERES FOR STUDIES OF THE PULMONARY CIRCULATION. **Rhodes, Buck A.; Zolle, Ilse; Buchanan, Julia W.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology, 92: 1453-60(June 1969).**

Studies in a variety of animals and the clinical trials in man suggest that ^{113m}In- and ^{99m}Tc-labeled human serum albumin microspheres can be used safely for evaluation of the distribution of pulmonary arterial blood flow and are potentially useful for other studies such as measurement of arteriovenous shunting. Diagnostic doses employ from 0.1 to 5 mg, which is 10^{-3} to 10^{-4} of the toxic dose in animals. The primary advantage of albumin microspheres over the other radiopharmaceuticals used for lung scanning is the increased uniformity of their size. The possibility of dividing a given batch of microspheres into fractions of different sizes and of labeling these microspheres with either of two widely used generator-produced radionuclides may provide additional advantages for future studies. (auth)

41376 ^{85}Sr BONE SCANNING IN THE EARLY DETECTION OF THE BONE MALIGNANCIES, ESPECIALLY METASTASES. **Higashiura, Toshimasa (Tottori Univ., Japan). Kaku Igaku, 6: 109-17(Mar. 1969). (In Japanese).**

After intravenous injection of 20 μCi of $^{85}SrCl_2$, profile scanning was performed. Additional administration of 100 μCi in patients with p-positive profile scanning was followed by area scanning in In IO patients, scanning revealed abnormalities earlier or more extensively than those visualized by roentgenography. Negative scans were obtained in five patients with marked lesions of bones on roentgenograms. In a case with malignant hemangioendothelioma of sacrum, negative scan was obtained on admission, but following radiation therapy enhanced new bone formation and positive scan were obtained. (NSA of Japan)

41377 RADIOACTIVE SCANNING OF THE PANCREAS AND SPLEEN. **Charlesworth, D.; Testa, H. J.; Watson, A.; Torrance, H. Bruce (Royal Infirmary, Manchester, Eng.). J. Roy. Coll. Surg. Edinburgh, 14: 152-6(May 1969).**

Results of 216 scans of liver, pancreas, and spleen with ^{131}I-albumin, ^{75}Se-methionine, and ^{99m}Tc-sulfur colloid, are reported, and difficulties encountered in developing the techniques are discussed. Patients were scanned 20 min after an intravenous injection of 200 mμCi of ^{75}Se-methionine. A preliminary liver scan, using ^{131}I-labeled heat-denatured human serum albumin or ^{99m}Tc-sulfur colloid, was performed in each case. The incidence of false negative results, the high percentage of cases in which the pancreatic image was obscured by the liver and poor delineation of the edge of the pancreatic image led to a study of ways of improving the technique. It was shown that the optimum time for beginning the ^{75}Se scan was 15 to 20 min after injection, at the time when background activity from circulating selenomethionine was minimal. It appeared that selenomethionine is rapidly metabolized in the liver and returned to the plasma incorporated into plasma proteins. Changes in prescan protocol did not produce a change in this pattern. A method of separation of the liver from the combined liver and pancreas scan by simultaneous injection of ^{99m}Tc-sulfur colloid and ^{75}Se-methionine, with the use of a ratio subtract device and computer analysis, was found to improve the results. Spleen scanning with 1-bromomercuri-2-hydroxypropane labeled with ^{197}Hg is also described. With this technique it was possible to delineate space-occupying lesions of the spleen, to detect aberrant spleens, to quantitate the degree of splenomegaly, as well as to determine the presence or absence of a normal spleen. (BBB)

41378 RADIOACTIVE DRUGS IN THE TREATMENT AND DIAGNOSIS OF TUMOURS. **Mitchell, J. S. (Addenbrooke's Hospital, Cambridge, Eng. Univ. of Cambridge, Eng.). Kerntechnik, 11: 346-53(June 1969). (In German and English).**

The possibilities of applying organic substances incorporating radioactive isotopes in the treatment and diagnosis of malignant tumors are reported. Consideration is given to the quantitative basis of the method and to the difficult problem of the choice of labeled compounds. Most of the work concerns the use of tritium and ^{131}I. So far the clinical results have proved to be modest, though sometimes encouraging. (auth)

41379 RADIOAUTOGRAPHY IN VITRO: A PROMISING METHOD FOR EVALUATING HUMAN GERMINAL EPITHELIUM. **Markewitz, Moshe; Veenema, Ralph; Fingerhut, Bruno (Columbia Univ., New York). Int. J. Fert., 14: 22-32(Jan.-Mar. 1969).**

A radioisotope method was developed for investigating human spermatogenesis and infertility. Testicular biopsy specimens obtained under sterile conditions were immediately placed in culture media with tritiated thymidine (20 μCi/ml). The tissue was then incubated for 24 hr at 37°C, then fixed. Histologic sections (hematoxylin and erythrosin) were prepared on glass slides, air dried, dipped in photographic emulsion (NTB_2), exposed for seven days, and subsequently developed. Radioautography was used to visualize cells that incorporated the label into newly synthesized DNA. In normal mature human testes, there is a constant ratio between germ cells that are in the process of DNA synthesis compared with those not synthesizing DNA at the time of tritium exposure. In these normal testes, at least 50% of the tubules show some degree of labeling, and thus, DNA synthesis. Some tubules contain as many as 25 to 35 labeled germ cells. These findings serve to characterize a normally functioning testis. This ratio of cells actively synthesizing DNA as compared with those that are not indicates an asynchronous rather than synchronous cell division in the germ cells. Results of ^3H-thymidine uptake in testicular biopsies from patients with oligospermia due to hypogonadism, varicocele, or other pathology are also described. (BBB)

41380 SPLEEN SCINTIPHOTOGRAPHY WITH ^{99m}Tc COLLOIDAL SULFUR. Ferlin, G. (Univ. Padua). Acta Isotop., 8: 225-35(Nov. 30, 1968). (In Italian).

Spleen scintiphotography with ^{99m}Tc colloidal sulfur by means of the scintillation camera allows a rapid and satisfactory visualization of the organ. It provides an approximative idea of the size of the spleen, an indication about the ability of the splenic RES to take up the radioactive colloid, and an idea concerning structural abnormalities. The closed circuit TV reexamination of the pictures improves the possibility of detecting potential uptake abnormalities. (auth)

41381 LUNG SCANNING: ADVANTAGES AND PITFALLS OF PHOTOSCANNING WITH CLOSED CIRCUIT TV CONTRAST ENHANCEMENT AND COLOR SCINTIGRAPHY. Macri, C.; Ferlin, G.; Ziliotto, D. (Univ., Padua). Acta Isotop., 8: 285-97(Nov. 30, 1968). (In Italian).

The results obtained in lung scanning by means of color scintigraphy are compared with those obtained by photoscanning together with closed circuit TV contrast enhancement. A few cases in which such a comparison resulted to be particularly significant are discussed. In lung scanning there seems to be no clear advantage of photoscanning without closed circuit TV enhancement as compared with color scintigraphy. However such an advantage becomes sure when a closed circuit TV evaluation of the images is added to the procedure. (auth)

Radiotherapy

Refer also to abstracts 41158, 41191, 41325, 41327, 41329, 41335, 41365, 41367, 41451, 41466, 41468–41470, 41472, 41474, 41475, 41477–41479, 41483, 41485–41488, 41490, 41493–41497, and 42804.

41382 (COO-1784-15) SURGERY AND ANESTHESIA OF THE THYROTOXIC PATIENT. Dobyns, Brown M. (Case Western Reserve Univ., Cleveland, Ohio). [nd]. Contract AT(11-1)-1784. 4p. (CONF-690526-1). Dep. CFSTI.

From Biennial Western Conference on Anesthesiology, Salt Lake City, Utah.

The advantages of radioiodine therapy for patients with Graves' diseases or patients who are poor surgical risks are discussed. The fear of carcinoma of the thyroid following radioiodine therapy is no longer a serious threat. The presence of late developing unrecognized hypothyroidism and myxedema is a serious problem following the radioiodine. It is frequently unrecognized in elderly patients. Surgery is the preferred form of therapy in young individuals, in women during pregnancy, and in adults in the childbearing period. It is also preferred in thyrotoxicosis where nodules are present in the thyroid. Surgery should be preferred where it is important to have a remnant of thyroid tissue that will maintain the patient in a euthyroid state. (auth)

41383 TREATMENT OF ACUTE LEUKEMIA. Henderson, Edward S. (National Cancer Inst., Bethesda, Md.). Seminars Hematol., 6: 271-319(July 1969).

Acute leukemia treatment has shifted in emphasis from an intensive search for a totipotential agent to multiple drug approaches aimed at maximum leukemic cell reduction. Despite suggestive evidence of nearly complete eradication, leukemic tissue usually recurs. Drug activities and drug regimens are reviewed, as well as possible models consistent with clinical and cell-kinetic investigations reported to date. (auth)

41384 DOSE RESPONSE CURVE OF LUNG TUMORS. Tobe, Tatsuo; Kato, Toshio (Gunma Univ., Maebashi, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 170-4(May 1969). (In Japanese).

The dose response curve of human tumor was obtained in two recurrent primary lung cancers and five metastatic tumors, measuring the diameter of them on serial roentgenograms. It was assumed that the tumors regressed to a certain volume at the end of radiotherapy, and at the same time, they began to regrow. The following equations were used to calculate the growth of recurrent tumors. Gompertzian equation: $dV/dt = \alpha e^{-\mu t} V$; Logistic equation: $dV/dt = \alpha(K-V)V$; Mayneord's equation: $dV/dt = \alpha(1 - (R - D')^3/R^3)V$. The minimum volume, to which the tumor had regressed following radiotherapy, was obtained by extrapolating the growth curve of the recurrent tumors to the point of termination of radiotherapy, then the volume fraction (v.f. = volume of tumor at the end of radiotherapy/volume of tumor at the start of radiotherapy) was calculated. Total dose of fractionated irradiation, n times with d R, was converted to the equivalent single dose (D) by the formula $nd = Dn^\theta$ where $\theta = 0.22$ or 0.33. Supposing that the volume fraction in fractionated irradiation was equal to that in single dose irradiation, and one hit; multitargets type of response, the extrapolation number (m) and Do were calculated. The following were obtained; $\theta = 0.22$: $m = 1.67 \pm 0.18$; $Do = 350 \pm 190$ R. $\theta = 0.33$: $m = 2.45 \pm 0.31$; $Do = 225 \pm 125$ R. (NSA of Japan)

41385 DIRECT IRRADIATION OF CEREBRAL GLIOMATA. Buckley, T. F. (Radcliffe Infirmary, Oxford). Clin. Radiol., 20: 219-23(Apr. 1969).

In the 10 year period 1957-66, 40 patients with cerebral gliomas were treated at Oxford using various methods of local irradiation, mainly radium bombs. The results are analyzed in 30 patients who were treated by tumor excision plus bomb insertion at the primary procedure, bomb removal seven days later, followed by a full course of external radiation. The results are compared with those achieved in patients treated by surgical excision alone or by excision combined with external radiation and it is clear that although there may have been an improvement in short-term survival the ultimate issue is not influenced. (auth)

41386 STUDIES ON THE RADIOSENSITIVITY OF THE UTERINE CERVICAL CANCER. ESPECIALLY UPON THE RETROSPECTIVE OBSERVATIONS ON THE TUMOR HISTOLOGY. Matsukawa, Takashi (Shinshu Univ., Matsumoto, Japan). Shinshu Igaku Zasshi, 17: 209-30(Nov. 1968). (In Japanese).

Retrospective observations on cases of uterine cervical cancer were performed, classifying them into groups according to their prognosis (two groups; poor prognosis, diagnosed as Stage I or II and died of cancer within 1 yr after leaving hospital; and favorable prognosis, diagnosed as Stage III or IV and lived five yr after treatment), their clinical course (three groups; early disappearing, intermediately disappearing, and late remaining groups based on the time of disappearance of cancer cells), and their primary response to probe irradiation (500R × 2) (two groups having high and low radiosensitivity), and the features of their cancer tissue structures before irradiation were studied. The results obtained are as follows; In general, adenocarcinomas have unfavorable prognosis and low radiosensitivity compared with squamous cell carcinomas. As to squamous cell carcinomas, prognosis is more favorable and radiosensitivity is higher in undifferentiated types than in differentiated types. Cases with a low degree of autodegeneration of cancer tissue are observed more in groups having poor prognosis, late-remaining cancer cells, and low radiosensitivity, and most of the cancers with rich vascular supply have a favorable prognosis and high radiosensitivity. Other factors, such as size of cancer nest, incidence of giant nucleus, mitotic index, stainability, property of nucleolus, pyknosis, swelling of nucleus, amount of stroma, cell infiltration, and so on do not seem to have a close relationship to radiosensitivity of cancer tissue. As mentioned above, among many factors in tissue structure of uterine cervical cancer before irradiation, especially in squamous cell carcinoma, three factors, namely, degree of differentiation, autodegeneration, and vascular supply are thought to be important for estimating its radiosensitivity. (NSA of Japan)

41387 STUDIES ON RADIOSENSITIVITY ON THE RESPECT OF TISSUE OXYGEN TENSION. PART I. THE SIGNIFICANCE OF TISSUE OXYGEN TENSION AS A FACTOR TO DECIDE RADIOSENSITIVITY, ESPECIALLY ON THE CERVICAL CANCER OF THE UTERUS. Hokura, Hajime (Shinshu Univ., Matsumoto, Japan). Shinshu Igaku Zasshi, 17: 141-61(Nov. 1968). (In Japanese).

In order to obtain some ideas on radiosensitivity of tumors, tissue oxygen tension was studied in Donryu-strain rats weighing 100 to 120 gm., bearing subcutaneous ascites hepatoma AH-109A on their thigh, and in clinical observations. The following information was obtained. On both animals and patients of uterine cervical cancer, the tumor oxygen tension was lower than that of the normal tissue. In uterine cervical cancer, there was no constant relationship between the oxygen tension and stage, amount of stroma, blood supply, or size of cancer nest. In general, on both animal experiment and clinical study, the tumor oxygen tension tended to increase after irradiation compared with that before irradiation. The degree of reduction of tumor at the seventh day after irradiation, on both experimental tumor and uterine cervical cancer, was as great as the oxygen tension before or after irradiation, and as great as the balance of the oxygen tension between, before and after the irradiation. But on uterine cervical cancer, no correlation was observed between the oxygen tension and the irradiation effect judged from histological findings. The survival rate of tumor bearing rats was high when the tumor oxygen tension before irradiation was high, but it had no correlation to the oxygen tension after irradiation or to the balance of oxygen tension between, before and after irradiation. When uterine cervical cancer was estimated by the oxygen tension before the irradiation together with the decrease in the rate of ^{32}P uptake [(^{32}P-uptake before irradiation-^{32}P uptake after irradiation) × 100/^{32}P uptake before irradiation] a clear correlation between its radiosensitivity and these factors was observed. (NSA of Japan)

41388 STUDIES ON RADIOSENSITIVITY ON THE RESPECT OF TISSUE OXYGEN TENSION. PART 2. THE FUNDAMENTAL EXPERIMENTS ON THE EFFECT OF BREATHING 5 PERCENT CARBON DIOXIDE AND 95 PERCENT OXYGEN AT ATMOSPHERIC PRESSURE ON TUMOR REGRESSION. **Hokura, Hajime (Shinshu Univ., Matsumoto, Japan). Shinshu Igaku Zasshi, 17: 162-75 (Nov. 1968). (In Japanese).**

The effects of mixed gas inhalation on transplanted subcutaneous ascites hepatoma AH-109A were studied using Donryu-strain rats weighing 100 to 120 gm. Experiments were designed to determine the effects of changing tissue oxygen tension. The following results were obtained. When 100% oxygen or 95% oxygen with 5% carbon dioxide (mixed gas) was inhalated, tissue oxygen tension rose immediately after the inhalation in both tumoral and normal tissues, reaching a plateau within one minute. The tissue oxygen tension in the case of 100% oxygen inhalation was twice that of air inhalation, and that of mixed gas inhalation was higher than that of 100% oxygen inhalation. This increase of the oxygen tension was more marked in the normal tissue than in the tumor. The degree of reduction of tumor after irradiation of rats was greater in both 100% oxygen and mixed gas inhalation than in the case of air inhalation, but there was no great difference between the former two groups. The disappearance rate of primary lesion was highest following mixed gas inhalation, followed by the 100% oxygen-inhaled group, and then the air-inhaled group. The incidence of metastasis was highest following mixed gas inhalation, followed by the air-inhaled group, and then the 100% oxygen-inhaled group. Fifteen day survival rates were highest following 100% oxygen inhalation, followed by the air-inhaled group, and then the mixed gas-inhaled group. As to the change of body weight as an indicator of side effect of irradiation, there was no difference among these three groups, and any direct side effect owing to the mixed gas inhalation was not observed. (NSA of Japan)

41389 STUDIES ON THE RADIOSENSITIVITY OF THE UTERINE CERVICAL CANCER. PART 1. SIGNIFICANCE OF RADIOACTIVE PHOSPHORUS (^{32}P) UPTAKE ON THE RADIOSENSITIVITY OF THE UTERINE CERVICAL CANCER. **Sakurai, Koichiro (Shinshu Univ., Matsumoto, Japan). Shinshu Igaku Zasshi, 17: 176-89(Nov. 1968). (In Japanese).**

In order to elucidate some relations between radiosensitivity of uterine cervical cancer and its ^{32}P-uptake, several investigations were performed using Donryu-strain rats weighing 100 to 120 gm., with transplanted subcutaneous ascites hepatomas (AH-109 A), and patients with uterine cervical cancer. The following results were obtained. On both the animal experiment and the clinical cases, ^{32}P-uptake by tumors after irradiation declined in comparison with that before irradiation. In rats, ^{32}P-uptake after irradiation of tumors made highly radiosensitive by injecting hydrogen peroxide solution, was lower than that of tumors having low radiosensitivity due to hypothermia. In the uterine cervical cancer, ^{32}P-uptake became higher as blood supply increased, cancer nests became larger, and stroma became scanty. No correlation between ^{32}P-uptake and the grade of histological differentiation was observed. The macroscopically judged radiosensitivity of the uterine cervical cancer was not clearly related to ^{32}P-uptake before the irradiation, but it seemed to be higher in cases whose ^{32}P-uptake decreased after the irradiation and the rate of decrease of ^{32}P-uptake [(^{32}P-uptake before irradiation—^{32}P-uptake after irradiation) × 100/^{32}P-uptake before irradiation] was great. The correlation was not found between ^{32}P-uptake or its decrease rate and the irradiation effect judged from histological findings. It is not conclusive, because only a few cases were studied, but adenocarcinomas seemed to have a low ^{32}P-uptake. (NSA of Japan)

41390 STUDIES ON THE RADIOSENSITIVITY OF THE UTERINE CERVICAL CANCER. PART 2. SIGNIFICANCE OF DEOXYRIBONUCLEIC ACID (DNA) ON THE RADIOSENSITIVITY OF THE UTERINE CERVICAL CANCER. **Sakurai, Koichiro (Shinshu Univ., Matsumoto, Japan). Shinshu Igaku Zasshi, 17: 190-208(Nov. 1968). (In Japanese).**

In order to settle what factors are related to radiosensitivity, DNA-amount and ^{3}H-thymidine labeling index of tumor cells were studied in Donryu-strain rats transplanted subcutaneously with ascites hepatoma AH-109A and with patients of uterine cervical cancer. The following information was obtained. In the animal experiment, ploidy of DNA became lower and DNA-rich cells appeared after irradiation. The ploidy was lower and fewer DNA-rich cells were found in the group made highly radiosensitive by injecting hydrogen peroxide solution than in the group having low radiosensitivity due to hypothermia. Also, in clinical study, the change of ploidy and appearance of DNA-rich cells following irradiation were observed. The radiosensitivity judged histologically was high in tumors having high ploidy before probe irradiation, tumors having low ploidy after irradiation, and in those whose ploidy diminished after irradiation comparing with that before irradiation. The radiosensitivity judged macroscopically was high in tumors whose ploidy diminished after the irradiation. No constant relation was found between appearance of the DNA-rich cells and the radiosensitivity. In both animal experiment and clinical study, ^{3}H-thymidine labeling index of tumors was lowered by irradiation. In the animal experiment, labeling index was lower in the group that was injected with hydrogen peroxide solution than in the group under hypothermia. But in the clinical study, labeling index was not clearly related to radiosensitivity. A closer correlation was observed between change of ploidy, intratumoral oxygen tension, and ^{32}P-uptake, and radiosensitivity, than between each of these factors and radiosensitivity. (NSA of Japan)

41391 THE INFLUENCE OF ANEMIA TO RADIATION EFFECT IN TRANSPLANTED TUMOR. STUDIES ON THE FRUCTOSE SARCOMA. **Tanaka, Norimoto; Maeda, Morimasa (Kyoto Prefectural Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 49-54(Apr. 1969). (In Japanese).**

Oxygen effect in radiotherapy of malignant tumors was emphasized and practical use of high pressure oxygen has become popular in recent years. On the other hand, the influence of anemia in radiotherapy is almost ignored and was studied by only a few people. In this paper, the growth and cure rates of transplanted tumor were investigated in normal and anemic mice. The dd strain mice were inoculated with a fructose sarcoma cell suspension of 3 μl in the right thigh and then assigned into two groups, normal and anemia. Anemia was induced by intraperitoneal injection of 0.125 mg/g phenylhydrazine hydrochloride 24 hr before irradiation. X-ray doses of 500, 1000, and 2000 R were given to the right thigh of mice of both groups, 48 or 72 hr after tumor transplantation. As the tumor growth curve was the same in non-irradiated mice of both groups, phenylhydrazine or anemia had no effect on the growth rate when not irradiated. The dose-dependent decrease of growth rate was seen in normal and anemic mice and in the latter less markedly than in the former for 3 weeks after irradiation. The cure rates at 60th day after irradiation were less in anemic than in normal mice at the dose levels of 500 and 1000 R. From these results, it seems that the radiosensitivity of a subcutaneous tumor in an anemic mouse is decreased in comparison with a normal mouse. (NSA of Japan)

41392 EFFECT OF HIGH-ENERGY PROTONS ON Vx2 CARCINOMA IMPLANTED IN THE LOWER ABDOMINAL WALL OF THE RABBIT: COMPARISON BETWEEN SINGLE AND FRACTIONATED IRRADIATION SCHEMES. **Danielsson, Mats; Engfeldt, Bengt; Fors, Bertil; Larsson, Boerje; Naeslung, John (Univ. of Uppsala). Acta Obstet. Gynecol. Scand., 47: 373-89 (1968).**

The reaction of malignant tissue to proton irradiation was studied with special attention to the pelvic organs. Well-nourished tissue was chosen as the site of tumor implantation; the anterior abdominal wall was selected because the operation could be performed here much easier and with fewer side-effects than implantation in the pelvic organs. The effect of a single proton irradiation of 3000 and 4000 rad on healthy rabbits and on rabbits with Vx2 carcinoma was determined. With the heavier dose and particularly in the smaller animals, damage was observed in the skin and also in the internal organs. With 3000 rad no such damage was observed. The results verified previous observations that a single irradiation with 3000 rad causes regression of Vx2 carcinoma. The results indicated that a dose of 1200 rad given on 5 consecutive days does not give better therapeutic results than single irradiation with 3000 rad under the experimental conditions used. Any differences between the results of the different irradiation schemes were probably in favor of the single irradiation. This conclusion is based on the observation that erythema and edema of the anus and vulva and also necrosis of the skin were observed among animals treated by fractionated irradiation but not among those given a single dose equivalent in its tumoricidal effect. It was concluded that single irradiation with 3000 rad in the rabbit causes regression of Vx2 carcinoma without causing any serious damage to the healthy rabbit tissues and that fractionated treatment with 6000 rad is not more effective. (BBB)

41393 BASIC STUDIES OF RADIATION THERAPY IN EHRLICH ASCITES CANCER. PART 2. THERAPEUTIC EFFECTS OF DOSES AND RADIATION INTERVALS. Nomura, Koji (Hiroshima Univ.). Hiroshima Diagaku Igaku Zasshi, 16: 1073-92(Dec. 1968). (In Japanese).

Whole-body x irradiation with changing doses and radiation intervals was given to mice with transplanted Ehrlich ascites cancer intraperitoneally or subcutaneously, and its therapeutic effect was studied. The results obtained are as follows; Radiation damage to normal tissue depended upon dose and radiation interval, and it was not desirable that single doses exceed 500 to 600R. From the standpoint of irradiation effect to the tumor, irradiation with high single doses and long intervals is effective. If the single dose is constant, the effect to tumor increases as the radiation interval becomes shorter and the total dose during a period increases. But the efficiency of the total dose for the effect to tumor does not always increase as the radiation interval becomes shorter. Various radiosensitivities in accordance with the stages of tumor growth were observed. The efficiency of irradiation is highest when the irradiation starts immediately after transplantation. Double irradiation was tried by changing the radiation interval, and the mitotic index was studied. The results showed that the effect was great in 48 hr intervals of irradiations when the single dose was 200R, and in more than 72 hr intervals when the single dose was 1000R. Considering a balance between the effect to tumor and the damage to normal tissue, 48 hr interval irradiation with a single dose of 300R and 72 hr interval irradiation with a single dose of 45OR produced the best therapeutic effect, when the overall time and total dose were constant. (NSA of Japan)

41394 RADIOTHERAPY OF THE LEUKEMIAS. Musshoff, K. (Univ., Freiburg i. B.). Internist, 9: 484-9(Dec. 1968). (In German).

Methods, effects, results, and complications of various radiotherapeutic approaches to the treatment of leukemia are reviewed, including extracorporeal and whole-body irradiation techniques. Localized irradiation of the spleen may be of value in early stages of the disease. Extracorporeal irradiation of the blood, using a technique calling for 150- to 800-rad irradiation of 10 to 40 l of blood 4 times per week for 11 weeks, is described. General improvement and decreased swelling of lymph nodes, spleen, and liver were noted but the bone marrow picture did not improve. Whole-body irradiation treatment of leukemia has generally been unsuccessful, even though survival times are sometimes increased. (BBB)

41395 OXYGEN TENSION OF CERVICAL CARCINOMA DURING THE EARLY PHASE OF EXTERNAL IRRADIATION. I. MEASUREMENTS WITH A CLARK MICRO ELECTRODE. Bergsjoe, P.; Evans, J. C. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 159-66(1968).

Changes in pO_2 of carcinoma of the uterine cervix were measured by repeated examinations during the early phase of external irradiation. Studies were conducted in 76 patients with carcinoma in the clinical stage II using Beckman's modified Clark microelectrode. The first examination was performed before treatment, the second and third examinations after 31-MeV x-ray tumor doses of 775 and 1700 R. Measurements at several sites were performed at each examination, and average values for tumor and normal tissue were calculated. In normal tissue the mean oxygen tension at each examination was about 2.5 times higher than in tumor tissue. During therapy there was a slight rise in mean oxygen tension, statistically significant between the first and third examinations, both for tumor and normal tissue. Although the observed increase in average pO_2 of tumor tissue at the dose rate used was small, it suggests the presence of fewer anoxic foci, with increasingly favorable conditions for a radiotherapeutic effect. (BBB)

41396 REACTOR-ACTIVATED APPLICATORS FOR TREATMENT OF CONJUNCTIVAL NEOPLASMS. Schulz, Milford D.; Wipfelder, Rosemarie (Massachusetts General Hospital, Boston). Radiology, 92: 1553-6(June 1969).

A technic for uniformly irradiating superficial conjunctival neoplasms, using individually constructed ^{32}P applicators, is described. These applicators, since they are precisely fitted to the lesion, spare maximally normal tissue and, since they are not activated until after fabrication, result in minimal exposure to the operator. The method of construction and activation is described, and two typical cases illustrating use and results are presented. (auth)

41397 AN ATTEMPT OF PRE-OPERATIVE IRRADIATION FOR THE TREATMENT OF RECTAL CARCINOMA. Kusumoto, Goro; Uryuhara, Tsuneo (National Hospital of Kure, Japan). Iryo, 22: No. 11, 41-5(Nov. 1968). (In Japanese).

It has been reported that rectal carcinoma could be treated with good results using pre-operative x irradiation. The effects of pre-operative irradiation of the pelvic cavity with ^{60}Co γ rays for cases of rectal carcinomas and the subsequent effects on surgery were examined. With an irradiation field of 15 × 15 cm, in two opposed fields, given 250 R six times a week, for a total dose of 5,000 R/3 to 3.5 weeks, and an interval between last irradiation and operation of 10 ~ 21 days, there were no disturbances for the surgical operations or for the post-operative conditions. Leukopenia, (under 3,500/mm^3) loss of appetite, and diarrhea appeared as side-effects of irradiation in a few cases. However it was not necessary to stop the radiation schedules when transfusion of nutritious fluids was used. Pre-operative irradiations were very effective since unchanged cancer cells could not be seen in the majority of removed tumor tissues. Strict judgment on the value of pre-operative irradiation should be held until a clear elevation of survival rate is obtained. (NSA of Japan) (TSS)

41398 TUMOR THERAPY WITH HIGH-ENERGY IONIZING RADIATION. Wideroee, R. Kerntechnik, 11: 312-17(June 1969).

Radiation therapy of tumors has two different aspects: firstly, the main technical problem of delivering sufficient doses to the tumor volume with only small doses to the normal tissue of the body; secondly, to use such doses and treatment schemes that a high selectivity between tumor and normal cells in the tumor bed is created. It is shown that under suitable conditions high-energy electrons can solve both problems better than other types of radiation. Only with radio-resistant and highly anoxic tumors may high linear energy-transfer radiations, such as 6 MeV neutrons, have a certain advantage. (auth)

41399 TECHNIQUES AND INDICATIONS FOR THE INTERSTITIAL IRRADIATION OF BRAIN AND PITUITARY TUMORS WITH RADIONUCLIDES. Mundinger, F. (Univ., Freiburg i. B.). Kerntechnik, 11: 333-45(June 1969). (In German and English).

On the basis of over 600 neurosurgical irradiation interventions, the surgical techniques and the indications are discussed for the permanent implantation of radionuclides (Ir 192, Au 198, Y 90) in otherwise inoperable tumors of the diencephalon and of the mesencephalon recalcitrant to conventional irradiation methods and for the elimination of the pituitary and of its tumors. In tumors of the cerebrum, brief interstitial irradiation of a duration of a few minutes (brachytherapy), particularly when carried out postoperatively, has also led to significantly better results. For brachytherapy we use the GammaMed® contact irradiation device. For bioptic checks and for locating the irradiation canules in the tumor we use exclusively the stereotactic targetting method (accuracy ± 0,5 mm). (auth)

41400 STEREOTACTIC TREATMENT OF AGROMEGALY. Conway, Louis W.; O'Foghludha, Fearghus T.; Collins, William F. (Univ. of California, Davis). J. Neurol., Neurosurg., Psychiat., 32: 48-59(Feb. 1969).

Complications and clinical findings in 11 patients treated with ^{90}Y pituitary irradiation for acromegaly are reported. With interstitial implantation of single or multiple point sources of ^{90}Y it was anticipated that there would be a differential effect on the growth-hormone-producing adenoma of acromegaly with sparing of the normal pituitary remnant. It was decided that no portion of the adenoma should receive less than 9000 R, no portion of the pituitary remnant more than 20,000 R, and no significant volume of nerve tissue more than 6000 R. The doses used were only 1/7th to 1/200th those used in previous studies, and were effective in arresting the disease. Precise placement of the ^{90}Y source is considered as the main cause of effective results and the low doses required (0.8 to 1.96 mCi). The potential complications and their incidence, transient and permanent, are listed. There was no incidence of rhinorrhea, bacterial meningitis, or optic nerve damage. There were 2 cases of transient cranial nerve palsy. Both of these were delayed for several days and lasted a matter of weeks. The delayed onset and transient character of the deficits suggest that they were secondary to swelling of the irradiated tumor. Evaluation of posterior pituitary function at 2 months revealed in 2 cases inadequacy of urinary concentration after 21 hr of water deprivation. A third case had clinically evident diabetes insipidus. The former 2 cases proved to be transient and a third case continues to require Pitressin 8 months after surgery. (BBB)

41401 TREATMENT OF THYROTOXICOSIS. Bufano, M. (Univ., Rome). Lancet, 1: 258-9(Feb. 1, 1969).

Use of ^{60}Co γ radiation, x rays, and ^{131}I for treatment of thyrotoxicosis is compared, particularly with regard to prevention of hypothyroidism. The use of x rays over other means of external and internal irradiation, in experience with >1000 patients is favored. The thyroid region was divided into 3 areas, and 100 rad were given every other day to one area each time. In all, each area was treated 4 times to give a total of 1200 (400 × 3) rad spread over 24 days. At the end of the first cycle the patients were followed up and, if necessary, a new cycle was started after a month of rest. Up to 5 cycles are needed for complete recovery, the average being 3. Complete treatment included administration of reserpine (up to 1.5 mg per day), barbiturates, bed rest, and a high-calorie diet. In the overwhelming majority of patients cure was obtained; relapses were few (about 10%), and were successfully treated by repetition of one or more cycles of x-ray therapy. No skin lesions occurred and no instances of hypothyroidism. (BBB)

41402 EXTENSION OF INDICATIONS FOR SURGICAL TREATMENT OF BREAST CANCER BY INTENSIVE PREOPERATIVE RADIOTHERAPY. Koszarowski, T. (Inst. of Oncology, Warsaw). Pol. Med. J., 8: 347-52(1969).

Translated from Pol. Tyg. Lek., 23: No. 25, 1968.

Poor results were obtained in treatment of breast cancers of a diameter exceeding 5 cm, following surgical excision alone. In these cases the surrounding tissues are infiltrated by the neoplasm, and metastases are present in the markedly enlarged axillary lymph nodes. An attempt was made to damage the tumor by means of x rays and then perform the operation. From 1948 to 1962, 259 such operations were carried out. Only 12% of cancers were completely destroyed by radiotherapy. A total of 47% of 5-year cures, 30% of 10-year cures, and 25% of 15-year cures were obtained. These results are much superior to those obtained by surgery or radiotherapy alone; however, the treatment lasts 4 months, and the postoperative course is more severe. Persistent edema of the arm occurs twice as frequently as after surgery alone. (auth)

41403 RADIATION THERAPY IN THE CLINICAL MANAGEMENT OF CANCER. Schulz, Milford D. (Massachusetts General Hospital, Boston). CA - Cancer J. Clin., 19: 18-26(Jan.-Feb. 1969).

Some radiobiological principles applicable to radiotherapy are reviewed, especially recent concepts of radiosensitivity. A classification of malignant tumors in decreasing order of radiosensitivity is given. Very radiosensitive normal tissues include: hematopoietic and lymphoid tissues, and germinative tissues (testes or ovary); very radiosensitive tumors include: malignant lymphomas and leukemias, embryonal tumors (seminomas or dysgerminoma); moderately radiosensitive are: squamous epithelium and glandular tissues, squamous cell carcinomas of the skin and mucous membranes, malignant glandular tumors (adenocarcinomas), and sarcomas; relatively radioinsensitive (radioresistant) are: connective tissue, bone, and nerve tissue, and osteogenic tumors, gliomas, and melanomas. Some radioresistant tumors are successfully treated when their location is such that large doses of irradiation can be given without irreparable damage to surrounding tissues. Generally, tumors likely to be cured by radiotherapy are those of only moderate radiosensitivity, those of epithelial or glandular origin. Highly radiosensitive tumors are often not cured, not because of the inability to destroy the local disease, but because a high degree of radiosensitivity is often correlated with a high degree of anaplasia, aggressive growth, and early dissemination. Cancers rarely if ever benefited by radiotherapy that should be treated by other means are: osteogenic sarcoma, radioresistant sarcomas such as fibrosarcomas and myosarcomas, malignant melanoma, carcinoma of the stomach, pancreas, liver, colon, small bowel, prostate, and metastatic carcinoma in the lungs and liver. The advantages of various radiation sources are reviewed, including x rays, γ rays, and energetic particles such as electrons, protons, and α particles. (BBB)

41404 RESPONSE OF RECURRENT CARCINOMA OF THE COLON TO COMBINED DEEP X RAY THERAPY AND CHEMOTHERAPY WITH 5-FLUOROURACIL. Topolnicki, W. (Cleveland Metropolitan General Hospital). Med. Radiogr. Photogr., 45: 19-22(1969).

Attempts were made to achieve synergism between the 5-fluorouracil and deep x-ray therapies without producing severe cutaneous and systemic reactions. Sixty patients were treated with the combination therapy during a 3-yr period. Most of the patients had inoperable advanced carcinoma of the gastrointestinal tract or the lungs. The doses of both 5-fluorouracil and radiation were smaller than those used by previous investigators; daily intravenous injections of 5-fluorouracil were administrated at the rate of 6 to 8 mg/kg of body weight per day 30 min prior to radiation therapy. In no case did the total dose of 5-fluorouracil exceed 3000 mg. The total tumor dose of radiation ranged from 1800 to 2200 R. It was believed that the combination therapy might minimize the development of cellular resistance and produce better results in patients with a positive tumor-host relation, even those with radioresistant tumors. There was difficulty in proving that 5-fluorouracil potentiates the action of x rays, since many tumors remained under control for several years following doses of radiation lower than those customarily used. However, it was apparent that given certain tumor-host relations, combined therapy with 5-fluorouracil and deep x-rays exhibited synergism in selected patients, even those having an advanced radioresistant tumor. (BBB)

41405 DIET IN IRRADIATED PATIENTS. Davitti, L.; Temporelli, A. (Univ., Turin. Sant' Amma Ospedale Ostetrico-Ginecologico, Turin). Minerva Radiol., 14: 151-6(Mar.-Apr. 1969). (In Italian).

Some general concepts of dietary management are described, and the importance of a correct diet in irradiated patients is stressed. Two basic diets respectively (2,100 and 2,300 calories) are suggested. From the qualitative standpoint these are high-protein, moderately high-carbohydrate, low-fat and high-vitamin diets. In many cases it is advisable to integrate the diet with protein- and vitamin-rich dietary products. (auth)

41406 HYPERBARIC RADIATION THERAPY: SALT LAKE CITY EXPERIENCE. Plenk, Henry P.; Card, Richard Y. (St. Mark's Hospital, Salt Lake City). pp 189-94 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Results of hyperbaric oxygen radiation therapy in a group of 153 patients are reported. Forty-five had lung carcinomas; 38 had lesions of the head and neck; 11 had bladder carcinomas; 9 had brain tumors. Patients were irradiated with cobalt-60 γ rays in a Vicker hyperbaric chamber. Doses were fractionated up to a total of 4800 R. Eleven cases of barotrauma were encountered and a number of other complications are itemized. The problem of metastasis development is discussed. It was concluded that, although some dramatically effective results were obtained, other tumors persisted, indicating the necessity of further study before a definitive evaluation can be made. (C.O.)

41407 APPROACH TO THE DETERMINATION OF INDIVIDUAL PATIENT SOAKING TIMES IN HYPERBARIC OXYGEN RADIATION THERAPY. Wootton, P. (Univ. of Washington, Seattle). pp 90-7 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

The use of miniaturized electrodes for measurement of O_2 pressure in tissues following soaking of patients in O_2 before irradiation treatment is discussed. Structure and physical characteristics of the electrodes are described. Results of polarographic measurements of venous O_2 pressures during O_2 respiration in a chamber at 30 lb gauge are reported. Methods of calculating soaking times for O_2 at various pressures are discussed, and applications of the method to studies in large tumor nodules are presented. The conclusions reached are that soaking is necessary for proper treatment, the optimum time is likely to be an individual parameter that may change during the course of treatment, direct measurement is impractical at present, but combinations of physiological data, tumor data, and measurements of venous O_2 pressure may provide useful information. (BBB)

41408 PHYSICAL ASPECTS OF RADIOTHERAPY WITH HYPERBARIC OXYGEN. Stickley, E. E. (Columbia Univ., New York). pp 98-109 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

The physical problems encountered in establishing an enhanced O_2 radiotherapy center are discussed. The instrumentation and control system for treatment with O_2 up to 4 atm pressure, irradiation control, methods of patient positioning, treatment planning, beam localization, radiation shielding, safety practices, hazards of accidental combustion in the O_2 chamber, O_2 leakage, irradiation damage equipment, and radiation sources, are discussed. Criteria for evaluation and validity of results, including factors such as personal bias, survival time, population sampling, and statistical analysis are considered briefly. (BBB)

41409 HYPERBARIC OXYGEN AND RADIOTHERAPY: CLINICAL EXPERIENCES. Churchill-Davidson, I. (St. Thomas Hospital, London). pp 156-61 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Patients whose tumors were considered too locally advanced to have a chance of cure by conventional radiotherapy were selected for hyperbaric oxygen therapy to attempt a demonstration of improved radiation response. All hyperbaric treatments were given a maximum tissue dose of 3500 to 3750 rads in 6 treatments in 18 or 19 days. Most were treated conscious and breathed oxygen at 3 atm pressure. If anesthetized they breathed oxygen at 4 atm pressure. Results are reported for 235 patients treated with hyperbaric O_2 and 81 control patients treated in air. Marked improvements were found in the survival time and the rate of sterilization of growth in the irradiated area. Some locations gave especially good results, and one area, the brain, had disappointing results. Particular note was made of the good response of secondary squamous carcinoma in lymph glands, which are notoriously radioresistant. The incidence of oxygen convulsions was low, and no harm resulted from them. (C.O.)

41410 EXPERIENCE IN MELBOURNE WITH USE OF HYPERBARIC OXYGEN COMBINED WITH MEGAVOLTAGE RADIATION IN 614 CASES OF ADVANCED MALIGNANT DISEASE. Van Den Brenk, H. A. S.; Madigan, J. P.; Kerr, R. C. (Cancer Inst. Board, Melbourne). pp 162-74 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Results of treatment of 614 patients with 4-MeV x rays at 4 atm of O_2 are reported. Each exposure was 40 min long. No mortality from the O_2 treatment was observed. Convulsions were observed in a very few patients, but there was no lung or brain damage from O_2 toxicity. Dose fractionations were established for treatments with doses from 2000 to 2900 R. The cancer clearance rate with hyperbaric O_2 was $\sim$ twice that obtained with x irradiation in air. Incidence of radionecrotic tumors was not greater after irradiation and hyperbaric O_2 treatment than in air, even after cumulative doses of 5000 to 7000 R given in 4 to 6 weeks. The radionecroses were precipitated by factors such as excessive smoking, alcoholism, infections, and dental extractions. Radiation sickness was rarely observed in hyperbaric O_2 treatments. Vulnerability of the brain and other neural tissue, lung, intestine, bladder, cartilage, and bone to various doses and treatment schedules were evaluated and the limitations of hyperbaric O_2 and megavoltage irradiation treatment were explored. (BBB)

41411 SEATTLE EXPERIENCE WITH HYBAROXIC RADIOTHERAPY. Wildermuth, Orliss (Swedish Hospital, Seattle). pp 175-82 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Results of treatment of several types of tumors are reported. Hyperbaric oxygenation was well tolerated by patients of all ages, even the debilitated. Clinical results were less than spectacular, and it was evident that anoxia was only one of the deterrents to successful control of tumors with radiotherapy. It was concluded that further study is needed in the application methods for hyperbaric oxygen in radiotherapy. The need for adequate controls in the demonstration of improved effectiveness is also stressed. (C.O.)

41412 PROBLEMS IN THE MANAGEMENT OF PATIENTS WITH HYBAROXIC RADIOTHERAPY. Wildermuth, Orliss (Swedish Hospital, Seattle). pp 127-33 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Procedures and complications of combined treatment with hyperbaric O_2 and radiation are discussed. In hyperbaria, problems of the accessory sinuses are found in less than 1% if decongestants are used prior to treatment. Compression of the middle ear is more common. Gas-producing bacteria in dental abscesses may occasionally produce pain requiring dental treatment. Decompression illness is not observed in hyperbaroxic radiotherapy. Intoxication from O_2 is observed infrequently. The effects of hyperbaroxic radiotherapy on body tissues normally at reduced O_2 tensions, such as cartilage, lens of the eye, cornea, outer layers of the skin and appendages, and scar tissue are described and an example of cartilage necrosis in hyperbaroxic radiotherapy is discussed briefly. Serious complications of O_2 intoxication can be avoided by attention to electrolyte balance, fever, fatigue, extreme agitation and restlessness, and extended stay in O_2 beyond a 1 hr limit. (BBB)

41413 PHYSICAL CHARACTERISTICS OF A ONE-MAN HYPERBARIC OXYGEN CHAMBER. Wootton, P. (Univ. of Washington, Seattle). pp 71-8 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

The physical characteristics and method of operation of a transparent double-walled hyperbaric chamber used for clinical studies of effects of combined radiotherapy and hyperbaric O_2 are reported. The communications system, rate of pressurization, temperature, humidity, gas purity, valving system, mode of gas exchange and flushing system, mechanical characteristics, protection against fire hazards, and equipment modifications are described. The chamber transmits $\sim$ 80% of ^{60}Co γ and 60% of x radiation having a half-value layer of 2 mm Cu. The variation of radiation transmission with field size and maximum error, electron build-up, tissue dose, and phantom depth dose measurements are discussed. Except for the surface dose, dose distribution of ^{60}Co γ radiation in tissue within the chamber at depths greater than the maximum absorbed dose may be determined with isodose curves measured outside the chamber. (BBB)

41414 PHYSIOLOGICAL EVALUATION OF PATIENTS SUBJECTED TO HYPERBARIC RADIATION THERAPY. Parker, R. G.; Wootton, P. (Univ. of Washington, Seattle). pp 110-18 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Complications observed in patients with radioresistant tumors who received fractionated irradiation treatment at 3 atm of O_2 are reported. The major complications included changes in pulmonary function observed after protracted hyperbaric radiotherapy of over 5000 R delivered in 79 days. Mild otalgia and otitis were observed after 40 treatments at 3 atm O_2. No changes were observed in visual acuity, refraction, lens or retina anatomy, or ocular tension. No symptoms of central nervous system toxicity or changes were observed. No changes were observed in the cardiovascular system, hematopoietic system, liver and kidney function, or endocrine system of the patients treated. (BBB)

41415 FRONTIERS OF RADIATION THERAPY AND ONCOLOGY. VOLUME 1. HYPERBARIC OXYGEN AND RADIATION THERAPY OF CANCER. Proceedings of the First Annual San Francisco Cancer Symposium, November 12-13, 1965. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968. 211p. DM 48.-; $11.50; 88s. (CONF-651158-(Vol.1)).

Various theoretical and applied effects of hybaroxic radiotherapy are reported and discussed. These include factors that affect tumor oxygenation, effects of pre-irradiation on cellular oxygenation, effects of anoxia on radiation injury and recovery, comparison of atmospheric and hyperbaric O_2 breathing in radiotherapy, physical characteristics and problems of use of a hyperbaric O_2 chamber, evaluation of patient soaking times, dosimetry under hyperbaric conditions, physiological evaluation and problems in management of patients with hybaroxic radiotherapy, long-term effects of hybaroxic radiotherapy, alterations of radiosensitivity of skin and other tissues under hyperbaric O_2, and clinical results of tumor treatment with hybaroxic radiotherapy, using x ray or megavoltage irradiation. Twenty separate abstracts were prepared for inclusion in NSA. One additional paper on factors affecting oxygenation of normal and neoplastic tissues was not within the scope of NSA. (BBB)(TSS)

For abstracts of individual papers see: 41327-41329, 41357-41361, 41406-41414, 41416, 41496, and 41497.

41416 OXYGEN EFFECT IN RADIOTHERAPY: HISTORICAL REVIEW. Churchill-Davidson, I. (St. Thomas Hospital, London). pp 1-15 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

The historical directions of studies of effects of O_2 in radiotherapy are reviewed briefly. Current lines of research that include studies of relative radiosensitivity of cells under different conditions of oxygenation, confirmation of presence and effect of anoxic cells in tumors, and various methods of overcoming the protection against irradiation that anoxia affords are described. Data on O_2 radiosensitivity, detection of O_2 effects and tumor anoxia by histological examination, cell survival curves, polarographic measurements of O_2 tension, and response of animal and human tumors to irradiation after O_2 inhalation are presented. The potentialities of tumor oxygenation by increasing the O_2, or first decreasing the O_2 in the tumor area by cutting off the blood supply and then administering increased irradiation doses are discussed. Results of various studies in this field are briefly summarized. (63 references)(BBB)

Blast and Thermal Effects

Refer also to abstracts 41298 and 41346.

41417 (ABCC-TR-12-67) LUNG CANCER AND ATOMIC BOMB EXPOSURE, HIROSHIMA-NAGASAKI, 1950-66. Wanebo, Clifford K.; Johnson, Kenneth G.; Sato, Kazuyoshi; Thorslund, Todd W. (Atomic Bomb Casualty Commission, Hiroshima, Nagasaki (Japan)). July 10, 1967. 17p. Dep. CFSTI.

Cancer of the lung was increased above normal expectation during the period 1950 to 1966 in persons who received radiation doses of 90 or more rad at the time of the Hiroshima and Nagasaki atomic bombs. In the large JNIH-ABCC Life Span Study sample, the ratio of observed to expected death certificate diagnoses was 1.9, and the ratio of principal autopsy diagnoses, 2.15. In the clinical ABCC-JNIH Adult Health Study sample, for which ascertainment must be nearly complete, the ratio was 1.6. These findings suggest an increased risk of lung cancer following atomic irradiation similar to that reported by Court Brown and Doll for patients given radiotherapy for ankylosing spondylitis. Smoking histories point to an increased risk of lung cancer among smokers of each sex. No significant differences were noted between more heavily exposed survivors with lung cancer and other subjects with lung cancer when comparisons were made as to age at onset of lung cancer, presence of other primary neoplasms, or histologic type, or as to other epidemiologic factors (occupation, smoking, and tuberculosis) commonly associated with increased risk of lung cancer. (auth)

Radiation Effects on Animals

Refer also to abstract 41355.

41418 ON THE PROBLEM OF THE KINETICS OF THE CELLULAR POPULATION IN THE CRYPTS OF THE SMALL INTESTINE IN THE X IRRADIATED MOUSE. Kononenko, A. M.; Farafonov, G. B. Arkh. Anat., Gistol. Embriol., 53: No. 12, 27-32(Dec. 1967). (In Russian).

A detailed study of changes in the volume of the whole cell population of the small intestine crypts occurred within 72 hours following total single x irradiation (doses of 700, 900, and 1200 rads) was carried out. Magnitude of the whole population of the crypt was determined as a product obtained by multiplying the average amounts of cell circular rows counted in the axial sections of the crypt and cells in the circular row counted in the transversal sections of the crypt. It was shown that studies conducted in the axial section of the crypt gave neither any notion of the real size of the cell population nor true characteristics of changes in the population, in particular after the exposure to irradiation. While counting of cells in the axial sections creates an impression that, at application of the above indicated doses, the crypts were half emptied within 24 hours after exposure to irradiation: the study of the whole crypt population showed that devastation involved almost three quarters of it. By 72 hours after the exposure to the dose of 700 rads the crypt population did not yet reach the control mean, while the number of cells in the axial sections exceeded the control value. Devastation of the crypt population during the first 24 hours after single total irradiation with the doses used is a result of a complicated process. If, during the first 8 to 10 hours after the exposure, ousting of the cells from the crypt onto the villus, absence of compensating reproduction, and, to a lesser extent, interphase death of the cells play an important role in crypt depopulation, then during the next 10 to 24 hours, in addition to ousting of the cells onto the villus, death of the cells due to aberrant mitoses played an important role in emptying the crypts. The lower the dose, the more distinct was the effect. As reproduction of cells is balanced by their postmitotic death, ousting of the cells onto the villi, in absence of compensating reproduction, will determine a degree of the crypt devastation. It may be assumed that this process is independent of the dose applied. (auth)

41419 BASIC STUDIES OF RADIATION THERAPY IN EHRLICH ASCITES CANCER. PART 1. INFLUENCE OF IN VITRO X-RAY IRRADIATION ON TRANSPLANTABILITY. Nomura, Koji (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 16: 1059-71(Dec. 1968). (In Japanese).

The relation between x-ray doses and the transplantability of Ehrlich's ascites cancer irradiated with x ray in vitro was investigated. As the preliminary experiment, the influences of the storage condition (temperature and time) and the dilution ratio of ascites cancer on the transplantation rate were researched. In the case of intra-abdomenal infusion of 0.1 ml of ascites (containing 5×10^6 cells), the transplantation rate was little changed until 24 hrs of storage at 0°C. As for the ascites of 0.1 ml, no influence on the transplantation rate was seen by dilution up to 50 times. The increase of average body weight of the transplanted mice decreased and the rate of success in transplantation declined as the degree of dilution increased. In the case of intra-abdominal infusion of 0.1 ml of x-irradiated ascites (containing 5.23×10^6 cells), the transplantation rate was not influenced by irradiation up to 500R, but it was inhibited by irradiation of more than 30,000R. The curve with the transplantation rate as an index that shows the effects of x-ray dose is an exponential function in the range of 500 to 10,000R. (NSA of Japan)

41420 COHERENT LIGHT (LASER) IN BIOMEDICAL RESEARCH. Edgerton, Milton T.; McKnelly, Lawrence O. (Johns Hopkins Univ., Baltimore). Plast. Reconstr. Surg., 43: 269-76 (Mar. 1969).

The effects of laser irradiation on animal tissues are reviewed on the basis of current trends in laser research. The laser microprobe in addition to its use in the analysis of functions of cellular constituents, is of value in quantitative spectroscopy. Single cells may be focused through a microscope objective and the laser projected through the lens system. The cells are vaporized instantly and the resultant gaseous plume analyzed directly by emission spectroscopy. Single red cells may be analyzed for iron or rare earth metal content, with great accuracy. A study of wound healing by time-lapse cinemicrography, after endothelial or epithelial cells have been injured by laser irradiation, is being used to answer basic questions such as the origin and role of endothelial cell migration in the construction of new blood vessels. The localization of a fine laser beam in sublethal doses permitted selective injury of separate parts of cells and the effects of such irradiation on the synthesis of DNA, RNA, and proteins could be studied. Supravital staining will assist most tissues in absorbing the laser energy of a given wavelength. Biological damage is produced by the laser in proportion to the amount of energy absorbed by the target tissue. The absorption depends on the content of either natural chromophores or experimentally added dyes. In tissue culture the electron-accepting activity of cytochrome c can be specifically inhibited by treatment, by a laser with the green wavelength of 5300 Å. Wavelengths of 6013 Å produced a similar effect on cytochromes a and a-3. Hemoglobin, myoglobin, cytochrome c, riboflavin, and carotene can all be specifically affected by appropriate wavelengths of laser energy, without disturbing adjacent structures. Thus the monochromatic nature of laser energy, as well as its small spot size, permits great selectivity of wavelength-dependent effects. Leucocytes, which contain no appropriate natural chromatophore, can be made sensitive to ruby laser energy through vital staining with Janus Green B. (BBB)

41421 RADIATION DAMAGE TO BULL SPERM MOTILITY. II. PROTON IRRADIATION MEASUREMENTS. Rikmenspoel, Robert (State Univ. of New York, Albany); van Herpen, Gerard. Biophys. J., 9: 833-44(June 1969).

An estimate of the length-to-width ratio of the radiation target in sperm was obtained by complementing x-ray experiments with irradiation by fast protons. Diluted bull semen samples were bombarded with a 24-MeV proton beam. It was calculated that the energy of the protons during the traverse of the sperm preparation decreased almost linearly from 22 to 13 MeV. In that energy range the stopping power increased from 24 to 37 MeV/g cm^{-2}, or ~50% Dose-response curves for the fraction of cells that survived and for the average velocity of the surviving cells were measured. Target theory indicated a cross section of the sensitive volume of 2.1×10^{-10} cm^2. Respiration measurements showed that the oxidative phosphorylation in the sperm remained coupled after the bombardments. The efficiency with which free energy from ATP hydrolysis was converted into mechanical work by the sperm was found to decrease after proton bombardment. The half-value dose for this effect was 2½ times higher than the half-value dose for motility damage. These respiration measurements indicated that the radiation damage is not to the metabolic system or to the contractile system in the sperm flagellum but to a control system for the motility. Application of the target theory showed that this control system is localized in a small element of ~1600 Å dia, which may be the centriole. (BBB)

41422 ROLE OF THE PHAGOCYTE IN HOST-PARASITE INTERACTIONS. XV. EFFECTS OF H_2O_2 AND X-IRRADIATION ON THE BACTERICIDAL ACTIVITIES OF PHAGOCYTE FRACTIONS. Mukherjee, A. K.; Paul, B.; Strauss, R.; Sbarra, A. J. (St. Margaret's Hospital, Boston). Contract AT(30-1)-3240. RES. J. Recticuloendothel. Soc., 5: 529-37(Dec. 1968). (NYO-3240-27).

In a study of the effects of concurrent x irradiation on the phagocytic and the bactericidal activities of guinea pig polymorphonuclear leukocytes (PMN), it was shown that irradiation effects the bactericidal activities of PMN but not the actual act of engulfment. Since x irradiation affected the intracellular event only, studies of the bactericidal activity of cell homogenates in the absence and presence of x irradiation were undertaken. Cell homogenates possessed bactericidal activity, and the activity was localized to a particular fraction sedimenting between 120 and 15,000 g. Maximal killing was noted in an oxygen atmosphere. Reduction in oxygen concentrations resulted in decreased killing. Freeze-thawing of the homogenate did not increase the bactericidal activity. Nonbactericidal concentrations of H_2O_2 were effective in increasing significantly the bactericidal activity of the active homogenate fraction. Concurrent x irradiation increased the bactericidal activity of the homogenate fraction when tested in an atmosphere of either oxygen, air, or nitrogen. Evidently the oxidative events, stimulated during phagocytosis, result in the production of H_2O_2 and this agent is a major component of the bactericidal system in the phagocyte. (BBB)

Invertebrates

Refer also to abstract 41284.

41423 ASPECTS OF MITOTIC PATHOLOGY FROM X RAYS AND MORPHOGENESIS OF HETEROPLOIDY IN GRANULOBLASTS: IN VITRO STUDIES USING PHASE-CONTRAST ACCELERATED MICROCINEMATOGRAPHY. Carosi, G.; Gerna, G.; Moratti, R.; Cerra, E. (Univ., Pavia). Haematologica (Pavia), 53: 66-77(1968). (In Italian).

Phase-contrast microcinematography was used to follow the formation of heteroploid granuloblastic cells in cultures of newt spleen irradiated with 25 R. Spleen cells of Molge vulgaris were x irradiated and examined 24 to 36 hr later. At the termination of an apparently normal metaphase, cells became progressively longer and the anaphase chromosomes migrated in the direction of the opposite pole. The asters developed an asymmetric configuration. It was concluded that the observed heteroploidy is brought about by 2 separate factors coexisting in the same abnormal karyokinesis: (1) formation of an asymmetric anaphase; and (2) atypical cytokinesis in a mitosis with asymmetric asters. It appeared that, whereas the asymmetric chromosome divisions during anaphase were the consequence of primary damage to the mitotic apparatus, the asymmetric cytokinesis is a secondary phenomenon due to the asymmetric partition of nuclear material. (BBB)

41424 RECOVERY AND OVERRECOVERY FROM ACUTE RADIATION INJURY AS A FUNCTION OF AGE IN DROSOPHILA. Baxter, R. C.; Blair, H. A. (Univ. of Rochester, N. Y.). Radiat. Res., 39: 345-60(Aug. 1969).

Recovery from radiation injury contributing to acute lethality was studied in imagoes of wild-type Drosophila melanogaster of various ages by giving a sublethal dose of x-rays followed after a variable interval by a second dose adjusted to permit determination of acute lethal dose, $LD_{50(1)}$. At all ages there is probably a latent period of about 6 hours before recovery begins, and thereafter it is probably exponential. Although it is clear that the half-time for recovery increases from about 5 hours at 1 day of age to 16 hours at 30 days of age, a satisfactory relation of recovery rate to age cannot be determined because, especially in young flies, complete recovery is succeeded by marked overrecovery, and the kinetics of the two processes are not separable. As measured by increase of lethal dose above its normal value, overrecovery may be as great or greater than the original injury, and it persists for the remainder of life, which, however, is shortened by the initial dose. We have assumed that life shortening is determined basically by injury to the cell nucleus and that acute lethality is determined by extranuclear injury. Nuclear injury appears not to recover. (auth)

41425 EFFECTS OF RADIATIONS ON ORAL REGENERATION IN STENTOR COERULEUS. Burchill, Brower R. (Univ. of Kansas, Lawrence). J. Exp. Zool., 169: 471-80(1968).

The effects of whole-cell irradiation with uv and γ radiation on regeneration in Stentor were examined to investigate the radiosensitivity of the nuclear/cytoplasmic interactions involved. Regenerating cells were irradiated with varying doses, at various times throughout the regeneration cycle, and with combined doses of both types of radiation. A germicidal lamp having a peak output of 254 nm and ^{60}Co were used as radiation sources. Average radiosensitivity varied both between cells from different cultures and between cells from any one culture on different days. The synchrony of regeneration in irradiated cells was always less than that of control cells. Regeneration was prolonged by both radiations. The primary response was an interruption in the regeneration cycle, starting soon after irradiation and leading to a delay in the completion of development. The relation of dose to delay, of cells irradiated early in regeneration, was linear. Early stages of regeneration were maximally sensitive, with the peak sensitivity to uv light occurring slightly earlier than that to γ radiation. Cells irradiated with combined doses of both radiations were more affected than cells exposed to either single radiation dose alone. (BBB)

41426 DIFFERENTIAL EFFECTS OF RADIATION ON EARLY GROWTH STAGES OF ADULT HYMENOLEPIS MICROSTOMA. Goforth, Cobia Dwight. Knoxville, Tenn., Univ. of Tennessee, 1968. 65p.

Thesis.

Changes in sensitivity to radiation are known to occur in many organisms during certain critical periods of development. Increased sensitivity has been correlated with periods of rapid change. Cestodes may, likewise, have similar periods of sensitivity. Young adults of Hymenolepis microstoma at three, four, five, and six days of age were removed from hosts and subjected to x-irradiation. Worms of each age were sorted into groups for exposure to 5000, 2500, and 1250 R, respectively. Irradiated worms or non-irradiated controls were transplanted into final recipient hosts and development was allowed to continue until each group reached 15 days of age. Various anomalies observed in the 15-day old strobilas were classified and counted. Sterility and missing testes were the most frequent anomalies encountered. The frequency of occurrence of these anomalies observed in 15-day old strobilas increased from younger to older worms subjected to irradiation. Sterility was thought to be due to damage to already formed segments, more of which were present in the older of the irradiated worms. This fact may explain why those worms had more sterile segments. However, some segments which presumably were being formed at the time of irradiation were sterile. Strobilas reared from worms irradiated at older ages exhibited a slightly greater number of missing testes than strobilas reared from worms irradiated in younger ages. Damaged cells of the neck region were responsible for missing testes. Presumably, cell proliferation in the neck region was greater in older worms than in younger worms. This would account for the increased radiosensitivity in older worms. (Diss. Abstr.)

Vertebrates

Refer also to abstracts 41164, 41223, 41226, 41227, 41235, 41236, 41239, 41244, 41247, 41249, 41250, 41253, 41258, 41261, 41265, 41267, 41269, 41277, 41281, 41344, 41347,41348, 41350, 41351, 41353, 41354, 41356, 41359–41362, 41392, 41393, and 41418.

41427 (AD–686057) COMPARISON OF RADIATION SENSITIVITY, ENDOGENOUS COLONY FORMATION AND ERYTHROPOIETIN RESPONSE FOLLOWING PROLONGED HYPOXIA EXPOSURE. Okunewick, J. P.; Hartley, K. M.; Darden, J. H. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Nov. 1968. 35p. (AFRRI-SR–68–22). CFSTI.

Experiments were carried out to evaluate the effect of continual hypoxia exposure on the hematopoietic system of mice. Three parameters were investigated: mortality sensitivity to x irradiation at dose levels between 675 and 775R, formation of endogenous erythroid colonies in the spleen after x irradiation, and response to erythropoietin injection. The results indicate that sensitivity to x irradiation is lessened, colony formation is greater, and erythropoietin response is enhanced if irradiation is performed 3 days after cessation of hypoxia on mice previously exposed for 3 to 4 weeks to one-half atmosphere of air. The findings suggest that prolonged stimulation of the erythroid system results in an enlargement of those hematopoietic compartments associated with cellular reproduction and with response to erythropoietic stimulation. (TAB)

41428 (AD–688375) RELATIVE RESISTANCE OF GERBILS AND RATS TO ACUTE ^{60}Co IRRADIATION. Belk, William F.; Gass, Arthur E. Jr. (School of Aerospace Medicine, Brooks AFB, Tex.). Mar. 1969. 11p. (SAM-TR–69–16). CFSTI.

Ninety Mongolian gerbils (Meriones unguiculatus) and 90 Sprague-Dawley rats (Mus norvegicus) were exposed to acute ^{60}Co γ radiation to determine the relative radioresistance of the two species and the $LD_{50/30}$ for the 12-week-old Mongolian gerbil. For each species, three groups of six animals were exposed at doses of 750, 850, 950, 1,050, and 1,150 R, at an approximate dose rate of 90 R/min. The gerbils were found to be significantly more radioresistant than the rats of comparable age. In a supplementary experiment to demonstrate more definitively the $LD_{50/30}$ of the gerbil, this species was exposed to dose ranges of 950 to 1,350 R. The $LD_{50/30}$ for the 10½-week-old rat was observed to be 856 R, and the $LD_{50/30}$ for the 12-week-old gerbil was 1,132 R. (TAB)

41429 (AD-688767) EFFECT OF EXOGENOUS ERYTHROPOIETIN UPON ERYTHROPOIESIS IN RADIATION-INDUCED ANEMIC RATS. Baum, S. J.; Varon, M. I.; Wyant, D. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Feb. 1969. 25p. (AFRRI-SR-69-3). CFSTI.

Experiments were performed to test the hypothesis that rats could be made permanently anemic by repeated mixed gamma-neutron irradiations, and that once the maintenance of normal circulatory red cell concentration was lost, the administration of exogenous erythropoietin could not restore the production of red cells to normal levels. Rats were exposed to nine periodic doses of 150 RADS mixed gamma-neutron radiation or to four periodic doses of 300 RADS. Hematocrits and erythrocyte counts obtained for 100 days or more after the final radiation exposure showed a significant reduction in erythrocyte production. This permanent anemia was not ameliorated by the treatment with five daily doses of either five units or 25 units of erythropoietin. These findings appear to strengthen the hypothesis that the permanent anemia is caused by a reduced capability for cellular proliferation due to accumulation of residual injury in stem cells. (TAB)

41430 (AD-688768) DEOXYCYTIDINURIA AND LYMPHOCYTOPENIA AS INDICATORS OF ABSORBED RADIATION DOSE IN RATS. Skidmore, W. D.; McHale, C. G. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Mar. 1969. 21p. (AFRRI-SR-69-5). CFSTI.

The effect of doses of mixed gamma-neutron radiations or 14 MeV neutrons on the urinary excretion of deoxycytidine (CdR) was evaluated as a biodosimeter in rats. The rats were exposed to doses in the range from 22 to 780 RADS. The excretion of CdR in the urine of irradiated rats during the 4- to 12-hr postirradiation interval was a function of dose over the range of 22 to 376 RADS. This response was similar for the different types of radiations. In a group of 10 rats exposed to the same dose of x rays (50, 150, or 450 RADS) on three successive days, the 4- to 12-hr postirradiation excretion of CdR was dose dependent after the initial exposure but not after the second and third exposures. The total CdR excretion after an accumulated dose of 150 to 1350 RADS approximated that of an equal single dose. The disappearance of circulating lymphocytes paralleled the urinary excretion of CdR. After lymphocytes had essentially disappeared following two 450-RAD doses of x rays, a third dose of 450 RADS induced less excretion of CdR by irradiated rats than by unirradiated control animals. Calculations of the amount of CdR excreted per deleted circulating lymphocyte suggest that there are other radiosensitive cells that contribute to deoxycytidinuria. (TAB)

41431 (AD-844294) ^{60}Co GAMMA IRRADIATION OF SHEEP: CORRELATIONS OF SIXTY-DAY MEDIAN LETHAL DOSE STUDIES WITH SELECTED BIOCHEMICAL, HEMATOLOGIC, AND PATHOLOGIC FINDINGS. Report for April-October 1967. Mobley, Thomas S.; DeFeo, Thomas C. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Oct. 1968. 92p. (AFWL-TR-68-83). CFSTI.

Ninety-seven female sheep, 2½ to 4 years of age, were exposed to bilateral whole-body ^{60}Co γ radiation at a dose rate of 11.0 R/min. Doses ranging from 180 to 415R midline air exposure (MAE) were administered at 11 different dose levels. Probit analysis of mortality data revealed a 60-day 50 percent (LD50 (60)) lethal dose value of 367R. Death distribution, hematologic, and gross and histopathologic findings implicated bone marrow failure as the major contributing factor causing death of the animals. The onset of death correlated with the onset of severe neutropenia and thrombocytopenia. Preexposure body weights served as a useful guide for predicting which animals would be most radiation sensitive. The course of radiation sickness in sheep was monitored throughout the experiment by selected hematological, biochemical, and electrolyte studies. (TAB)

41432 (AEC-tr-7086) LEUKEMOID REACTION FOLLOWING ^{90}Sr INCORPORATION IN RATS. Boegler, F.; Kriegel, H. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Blut, 17: 345-50(1968). 8p. Dep. CFSTI.

During investigations of the radiotoxicological effects of ^{90}Sr in rats, data were obtained on injury to the hematopoietic system. Hematological studies were subsequently initiated. Rats were administered 10 μCi of $^{90}Sr-^{90}\gamma$ intraperitoneally, and following spontaneous death, a series of blood analyses were conducted. Results revealed a significant rise in leucocyte count following an initial drop. No essential increase in young myeloid or lymphoid cells was determined. Morphohematographic studies revealed a high proportion of nuclear anomalies including fracturation and formation of spores and nuclear bodies. Histological investigations revealed leukemoidal infiltrations in tissues of 78% of the animals and osteosarcomas in only 4%. The existence of a threshold for leukemic and leukemoid reactions following ^{90}Sr administration is suggested. (E.R.B.)

41433 (ANL-Trans-764) STUDIES ON COMBINED INJURIES. REPORT I. SIGNIFICANCE OF THE TIME BETWEEN WHOLE-BODY IRRADIATION AND SKIN LESIONS FOR THE SURVIVAL RATE OF MICE. Langendorff, Hanns; Messerschmidt, Otfried; Melching, Hans-Joachim. Translated for Argonne National Lab., Ill., from Strahlentherapie, 125: 332-40 (1964). 13p. Dep. CFSTI.

An open skin lesion occupying about 5% of the body surface leads to a mortality of 7% in mice. If an animal with such a lesion is subjected to a whole-body x irradiation of 510 R, corresponding to a LD 26/30, the mortality rises to 85 to 95% if the lesion is inflicted 2 to 8 days after irradiation. However, if the lesion is inflicted before irradiation, the mortality is not increased, but a tendency toward an increase of radioresistance was observed. This increased radioresistance seems to be parallel to the protective effect observed in laparotomy and splenectomy before and after sublethal whole-body irradiation. Possible causes changing the mortality in the case of combined damages are discussed. (auth)

41434 (RLO-2056-5) LOW-LEVEL CHRONIC IRRADIATION OF SALMON. Annual Progress Report. Donaldson, Lauren R. (Washington Univ., Seattle. Coll. of Fisheries). July 1, 1969. Contract AT(45-1)-2056. 9p. Dep. CFSTI.

Fertilized eggs of Chinook salmon were γ-irradiated at 10 R per day, or a total of 820 R by the time the yolk sac was absorbed and the young fish were removed from the incubators and placed troughs to start the feeding period. Results showed no significant difference in survival between irradiated and control fish. Observations of malformations in control and irradiated fish revealed no statistically significant differences. A comparison of the growth rate of irradiated and control fish showed that the controls exceeded the irradiated by a slight but consistent margin. Tables and graphs are presented to show results. (H.L.W.)

41435 EFFECT OF SMALL REPEATED DOSES OF IONIZING IRRADIATION ON THE HAEMATOPOIESIS AND BLOOD COAGULATION SYSTEM IN AN EXPERIMENT. Dzhaparidze, T. N. (Inst. of Experimental and Clinical Surgery, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 54: 493-6(May 1969). (In Russian).

Fifteen mongrels were repeatedly irradiated with a dose of 50 R. The results of the observations have shown that clinical changes following the exposure were not pronounced. Changes in peripheral blood started after a total dose of 200 to 250 R ($P < 0.001$). Changes in the three phases of the coagulation system began after a total dose of 150 to 200 R. The activation of the blood anticoagulation system beyond doubt plays a significant role in the reduction of the activity of a number of components in the blood coagulation system. (auth)

41436 EFFECT OF PANTOTHENIC ACID DEFICIENCY ON THE RADIATION SENSITIVITY OF RATS. Gazdagh, Istvan; Szorady, Istvan (City Council Hospital, Oroshaza, Hungary. City Children's Hospital, Szeged). Kiserl. Orvostud., 21: 116-18(Apr. 1969). (In Hungarian).

A state of pantothenic acid deficiency, produced by the simultaneous application of pantothenic acid-antivitamin (ω-methylpantothenic acid) and a diet free of pantothenic acid, results in an increased post-irradiation mortality in comparison to the controls. In the deficient group of animals, there are more frequent changes in the fur and cases of skin suppuration. In other respects (leukocyte count, body weight, appetite), there were no demonstrable changes between the two animal groups. (JPRS)

41437 X IRRADIATION OF PREPUBERTAL BOVINE LEYDIG CELLS. Corwin, Louis Alfred Jr. Fort Collins, Colo., Colorado State Univ., 1968. 119p.

Thesis.

Male Holstein calves at either 5 or 8 months of age were exposed to testicular irradiation of either 400 R or 800 R to determine radiation effects on Leydig cell morphology and function.

Relative and absolute amounts of testicular interstitial tissue were determined. Spermatic vein blood was collected at the time of irradiation and 3 months later, at the time of castration, for androgenic steroid analysis to assess function. The relative amount of interstitial tissue in the testis was determined with a histologic line-intercept method. This percentage decreased with age and increased with radiation dose while testis weight decreased with increased dose. These were the only parameters that indicated a dose effect. The actual interstitial volume was calculated as the product of testis weight and interstitial tissue percentage. Interstitial volume did not change in either control animals or irradiated animals with age, however, interstitial volume was 20% less in the irradiated animals at all ages studied. The concentrations of the main androgenous steroids, testosterone and androstenedione, increased between 5 and 8 months and then decreased and was not affected by radiation. However, the secretion rate of both steroids was reduced by radiation due to reduced blood flow which may have been directly related to tubular shrinkage. The ratio of testosterone to androstenedione increased between 5 and 11 months and was not influenced by radiation. The reduced steroid output did not affect body growth of any animals nor the seminal fructose in the 11-month-old animals. It was speculated that reduced secretion rate of testosterone might impair the recovery of seminiferous epithelium from radiation damage. (Disser. Abstr.)

41438 INDUCTION OF GASTRIC ADENOCARCINOMA IN MICE BY LOCALIZED X-IRRADIATION. **Hirose, Fumio (Hiroshima Univ.). Gann, 60: 253-60(June 1969).**

The gastric region of 21 82- to 88-day-old CF_1 strain female mice in Group I was irradiated with 1,500 rads of x ray at 1-week intervals for a total of six exposures (total radiation dose, 9,000 rads) and 24 59-day-old CF_1 strain mice of both sexes in Group II were irradiated with 2,000 rads of x ray at 1-week intervals for a total of five exposures (total radiation dose, 10,000 rads). In Group I, 17 of 21 mice survived for more than 16 weeks after the initial irradiation; mucosal atrophy of the glandular stomach was seen in 100% of the mice, ulceration in 88%, atypical hyperplasia or precancerous change in 35%, and gastric adenocarcinoma in 12%. In Group II, 18 of 24 mice survived for more than 14 weeks after the initial irradiation; mucosal atrophy of the glandular stomach was seen in 100% of the mice, ulceration in 78%, atypical hyperplasia or precancerous change in 44%, gastric adenocarcinoma in 28%, and squamous cell carcinoma in 6%. A total of seven cases of gastric adenocarcinoma was observed, two of which had metastasis to the pancreas or mesentery. (NSA of Japan)

41439 THE EFFECT OF PARABIOSIS, HORMONE TREATMENT, AND IRRADIATION OF THE IMMUNE RESPONSE AND SERUM PROTEINS OF THE CHICKEN (GALLUS DOMESTICUS). **Morrissey, J. Edward. Columbia, Mo., Univ. of Missouri, 1968. 187p.**

Thesis.

The immune response and serum protein changes of White Leghorn chickens (Gallus domesticus) were studied in chemically bursectomized birds following either parabiosis or irradiation, and in intact birds following hormone treatment or irradiation. The parabiotic studies were carried out in order to establish that the contribution of the Bursa of Fabricius to immune development in the chicken could be transferred from an intact chicken to a bursaless chicken via the circulatory system. The results showed that transfer of immune competence was possible and that this transfer does effect the changes which occur in the serum protein fractions following immunization. The chicks were paired at one, two and three weeks of age and were joined for either seven or eight days. Hormone treatment involved, in one series, treatment with testosterone propionate (TP) or corticosterone (Comp. B). The birds were treated from the third to fifth week of age and an involution of the Bursa of Fabricius was noted. A second series involved the use of 0.2 per cent iodocasein which was fed from the first to fifth week of age in an attempt to enhance maturation processes. The results of the steroid experiment showed that TP caused an increase in the ability of the chickens to produce antibody to rabbit erythrocytes, while Comp. B had no effect on antibody production. The responses seen after feeding of iodocasein differed, depending upon the presence or withdrawal of iodocasein following immunization. Chickens removed from the diet upon immunization with rabbit erythrocytes showed significantly higher, and those left on the diet showed significantly lower, antibody production than the controls. When those animals left on the diet at the initial immunization were removed from the diet, and given a booster inoculum, the level of antibody production was significantly higher than the control chickens given a similar inoculum. The changes which occurred in the serum protein fractions were consistent with the antibody responses. In the irradiation experiment the animals were irradiated on the day of hatching at a level of 500 R. Electrophoretic patterns of the plasma of irradiated birds were examined for a five week period. The chickens were divided into four groups: intact controls, intact irradiated, bursaless controls and bursaless irradiated. The bursaless irradiated animals showed a significant decrease from bursaless controls in total protein values at two, three and five weeks of age, in gamma globulin values at three and five weeks of age, in $beta_1$ globulin values at four and five weeks of age and $alpha_1$ globulin values at four and five weeks. The bursaless controls showed a significantly higher level in total serum protein values than the intact controls at three weeks of age only, $beta_1$ globulin values at two, three, four and five weeks and $alpha_1$ globulin values at one through five weeks. The irradiated bursaless chickens therefore showed a hypogammaglobulinaemia but not an agammaglobulinaemia when measured by cellulose acetate electrophoresis. (Disser. Abstr.)

41440 GROWTH AND DIFFERENTIATION OF SKIN EPITHELIUM IMPLANTED ACCORDING TO F. M. LAZARENKO'S METHOD INTO IRRADIATED ORGANISMS. **Chekulaeva, L. I. (Inst. of Experimental Medicine, Leningrad). Arkh. Anat., Gistol. Embriol., 55: 42-51(1968). (In Russian).**

Fragments of the skin epithelium obtained from non-irradiated rat embryos 19 days old were subcutaneously implanted after Lazarenko's method to rats (100 to 120 gr of weight) subjected to total x irradiation (dose of 650 rad, LD 75/30). The implants were studied at various post-operation periods from one to 21 days. Methionine ^{35}S (0.5 mcc/g) was administered 4 hours (and in the 10-day experiment three days) prior to sacrifice of the animal. Counting of ^{35}S tracks was used to determine intensity of the protein metabolism. Hemorrhages were found to be a main factor inhibiting development of implanted tissues in acute irradiation sickness of the recipient. They produce a delay in development of the granulation tissue at the first stage of growth of implants. However proliferation of the epithelial cells and differentiation thereof were of the same rate and intensity, as in the intact organism. Migration rate of the cells, characterizing the rate of physiological regeneration of the epidermis was the same in the implants of both, irradiated and non-irradiated recipients. Ability of the cutaneous epidermis to form hair and sebaceous glands was fully preserved in the irradiated recipient. Intensity of protein metabolism at all implantation stages was the same in the epidermis of intact and irradiated recipients. Acute irradiation sickness produced by total x-ray exposure (lethal and sublethal doses) of the recipient did not essentially affect proliferation, differentiation and potencies of the epithelium. (auth)

41441 CHARACTERISTICS OF THE DEVELOPMENT OF ARTERIAL COLLATERALS UNDER CONDITIONS OF LOCAL ROENTGENOLOGIC IRRADIATION. **Zhdanova, N. V. Arkh. Anat., Gistol. Embriol., 55: 61-5(July 1968). (In Russian).**

Using an angiographic method and counting of arteries exceeding 50 microns in diameter, the development of arterial collaterals after cutting the femoral artery in the rabbit was studied. The investigation was carried out one, three, and six months postoperation. The animals were exposed to local single and fractionated irradiations with doses of 1500, 3000, and 5000 R in the region of the femur supplied (with the femoral artery, 24 hours prior to the operation). It was found that single irradiation inhibited the developmental process of collaterals, particularly affecting the vascular reconstruction. A degree of irradiation injury of the vessels was considerably increased with increase of radiation dose. At the later post-operation and post-irradiation terms, the delay in the development of collaterals was gradually effacing. Irradiation dose of 5000 R brought about almost irreversible alterations. Fractioned irradiation, when a dose of 3000 R was applied every third day during six months, was less harmful for the blood vessels, than a single irradiation with the same dose. (auth)

41442 CRITICAL PERIODS OF BONE DEVELOPMENT IN THE HIND EXTREMITIES OF THE CHICK EMBRYO. **Puchkov, V. F. Arkh. Anat., Gistol. Embriol., 52: No. 7, 37-44(July 1967). (In Russian).**

Chick embryos at the age of 2 to 10 incubation days were exposed to total x irradiation (600 R). Several critical periods in the development of the leg skeleton bones were found as follows: 2 incubation days was the critical period in the development of the whole leg; 4 incubation days was the critical period in the development of tibia; 5 incubation days was the critical period in the development of tarsometatarsus; 6 incubation days was the critical period in the development of digits and claws. The author raises a question of correlationship between critical periods in the development of the extremity and stages of its phylogenetic progress. It has been assumed that the critical developmental periods in embryogenesis correspond to the periods of phylogenetic transformations. (auth)

41443 RESPONSE OF LIVER TO γ IRRADIATION. Nomura, Setsuo (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 16: 993-1043(Dec. 1968). (In Japanese).

Histological changes in the liver of rabbits were studied following single doses of ^{60}Co γ radiation. Implantation of ^{60}Co tubes resulted in fibrotic lesions clearly demarcated from normal liver tissue. Cells of the reticuloendothelial system of the rabbit liver showed a decreased ability to ingest ^{198}Au colloid following single doses of 3000 to 7500 R. Following irradiation, an increase was observed in SGOT, SGPT, serum fibrinogen, and NH_3. Clinical data revealed that radiotherapy was effective for hepatic metastases of malignant lymphoma and ovarian tumors. (NSA of Japan)

41444 LIGHT AND ELECTRON MICROSCOPY OF THE OLFACTORY BULB OF NORMAL AND EXPERIMENTALLY TREATED RATS. Estable-Puig, Juan Francisco. Stanford, Calif., Stanford Univ., 1968. 315p.

Thesis.

Olfactory bulbs of albino rats were fixed by perfusion with chrome osmium, formaldehyde or glutaraldehyde fixatives, and embedded in Epon. Thick sections were stained with paraphenylenediamine. Thin sections were stained with uranyl acetate and lead hydroxide or lead citrate. Silver impregnated controls were performed. Frozen sections were utilized for polarizing microscopy. Radiation injury was caused by exposing the head of body shielded animals to a 18,000 roentgen dose of 250 KV x-rays. Thermosurgical lesions were performed by puncturing the bulb with a hot needle. The ablation of the olfactory mucosa was surgically done through the frontal and nasal bones. The section of the olfactory nerve was done by a transorbital approach and that of the peduncle by a superior intracraneal route. Acute radiation injury results in a selective necrosis of some of the granule cells with relative sparing of large neurons, and an intense accumulation of glycogen in the astrocytes. The latter was unspecific as it also occurred in the tissue adjacent to the thermosurgical wounds and to a lesser extent in the processes close to and surrounding degenerating terminals. Degeneration of the granulo-mitral reciprocal synapses occurs at the granular side of the contact. This alteration is presynaptic in relation to the granulo-mitral pathway but postsynaptic if referred to the mitrogranular direction. Following the section of the peduncle, degeneration of some myelinated fibers and terminals took place at the strata granulare internum, plexiforme and glomerulare. Synaptic degeneration of olfactory terminals was observed after the unilateral ablation of the mucosa. Similar results were obtained after sectioning the olfactory nerve. (Diss. Abstr.)

41445 CHARACTERISTICS OF MURINE MYELOID LEUKEMIA COLONIES IN THE SPLEEN. Tanaka, T.; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Cancer, 23: 197-203(1969).

A myeloid leukemia occurring in the inbred strain of RFM/Un mice was studied by examining colonies produced in irradiated recipient mouse spleen. The femora were removed at various stages from mice which had been injected previously with about 10^5 leukemic cells of RFM/Un. Bone marrow cell suspensions were injected into x-irradiated (900 rad) 3- to 4-month-old female RF mice for assay. The irradiated and injected mice were killed 9 days later and their spleens removed and fixed for colony counts. There was a linear relation between the mean number of colonies per spleen and cell inoculum, at the range of 2×10^3 to 1.2×10^4 leukemic cell inoculum sizes. Above this range, colonies started to show confluence, making it difficult to count them. Suspensions of 5×10^4 cells were prepared from discrete colonies and were injected into normal, unirradiated syngeneic mice. They died 13 days later with leukemia. The growth curve extrapolated at 2 hr to about 5 colony-forming units per femur. This value was experimentally confirmed by injecting appropriate dilutions of bone marrow cells into assay mice, 2 hr after injection of 1.2×10^5 leukemic cells into irradiated (900 rad) donor mice. Assuming one femur as about 5% of the total hemopoietic space in the mouse, the plating efficiency of the injected leukemic cells is about 1 : 1200 in the marrow. Microscopic features of myeloid colonies were compared with other already described colony types. (BBB)

41446 EFFECT OF PROTEIN AND AMINO ACID NUTRITION ON RADIATION DAMAGE IN MICE. 1. EFFECT OF DIETARY PROTEIN NUTRITION ON SURVIVAL OF MICE EXPOSED TO TOTAL-BODY γ-IRRADIATION. Tanaka, Seiei (Tokyo Metropolitan Isotope Research Center). Eiyo To Shokuryo, 22: 182-7 (Apr. 1969). (In Japanese).

Male dd-weanling mice were fed on 18% casein diet and on 6% casein diet for two or three weeks. The survival rates of mice exposed to a single sublethal dose of whole-body γ irradiation (1,000 R) were observed. The deficiency in protein before irradiation lowered the survival rates of mice. But the decrease in survival rates could be overcome remarkably by the supplement of adequate protein immediately after irradiation. However, addition of excess amount of protein showed an unfavorable influence. (NSA of Japan)

41447 RELATIVE BIOLOGICAL EFFECTIVENESS AND RECOVERY RATE IN MICE EXPOSED TO FAST NEUTRONS. Yoshinaga, Haruma; Sasaki, Hiroshi (Kyushu Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 181-4(May 1969). (In Japanese).

The relative biological effectiveness (RBE) of fast neutrons and recovery rate from lethal damage in CF #1 female mice exposed to 14.1 MeV neutrons were subjects of this study. The animals were 10 weeks old, with a mean weight of 23 ± 3 gm, at the time of irradiation. The neutron beam was obtained by T(d,n) reaction. RBE of the fast neutrons to 180 kVp x-rays (HVL 1.03 mm Cu) was found to be 1.22 for an $LD^{50}/_{30}$ incurred by a single whole-body exposure. For dose fractionation, mice were irradiated with paired equal doses of fast neutrons at a 3-day interval. The recovery rate at this interval was 44.3% for an $LD^{50}/_{30}$. (NSA of Japan)

41448 EFFECTS OF X IRRADIATION ON REJECTION OF TRANSPLANTED SCALE IN GOLDFISH. Kukita, Yasuko; Egami, Nobuo (National Inst. of Radiological Sciences, Chiba, Japan). Dobutsugaku Zasshi, 78: 112-13(Mar. 1969). (In Japanese).

In allogeneic transplantation of a small piece of the skin with scale, the transplants were rejected by nonirradiated goldfish within 20 days at 25°C. However, if scale was transplanted into fish irradiated with x ray doses of 100 or 500 R, some of the allografts survived for 30 days or more. The inhibitory effects of x rays on the rejection were clearly demonstrated only when the operation was carried out within 5 days after irradiation of the recipient. The x ray effects disappeared almost completely within 3 weeks after irradiation at 25°C. This disappearance of the radiation effects is compared with the previously reported phenomenon of recovery from radiation injury in goldfish. (NSA of Japan)

41449 EXPERIMENTAL STUDIES ON RADIATION PROTECTION BY TAURINE. Sugahara, Tsutomu; Nagata, Hiroharu (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 29: 156-61(May 1969). (In Japanese).

The effect of taurine on the survival of repeatedly irradiated mice was confirmed by repeated experiments. Male dd/YF mice at 60 days of age were irradiated with ^{60}Co γ ray of 365 R once every week until the death of the animal occurred. Taurine was given subcutaneously at a dose of 1, 5, and 10 mg, or per os by giving 0.1, 0.3, and 3% solution for drinking water. The increase in survival time was observed at higher doses. Finally mice fed pellets containing taurine in 3%, vitamin B_6 in 0.1%, and both combined showed the increased survival of about 26, 21, and 45 percent respectively. ^{59}Fe uptake in the spleen and femur was studied in mice drinking a taurine solution. But the mechanism of the taurine effect remains to be elucidated. (NSA of Japan)

41450 EXPERIMENTAL STUDIES ON THE INFLUENCE OF X RADIATION IN THE MARGINAL PERIODONTIUM. Schuele, H.; Betzold, J. (Univ., Erlangen, Ger.). Deut. Zahnaerztl. Z., 69: 140-8(Feb. 1969). (In German).

The pathogenesis of radioinduced periodontal lesions was investigated in 8 young dogs whose jaws were x irradiated with single doses of 4000 R or 6 doses of 1000 R (to give a total of 6000 R). Histologic studies were made of gingiva and periodontium 3 to 5 months later. Only one-half of the jaw was irradiated; the contralateral side was not irradiated and served as a control. Periodontal lesions which could be observed clinically after irradiation primarily developed on an inflammatory basis and were regarded as progressive, chronic, marginal periodontitis. They included ulcerations, infiltration of the gingiva with leukocytes, breakdown of the bony periodontal structures, fibrosis with clump formation by the fibers, vascular scleroses, and dilatation of the bone-marrow spaces. In addition, in some cases necrosis of the bony periodontal structures was observed. Similar to osteoradionecrosis, it was interpreted as the combined injury produced by the effects of radiotherapy and infection. Clinical implications of these experimental findings are discussed. Extraction of all teeth with pre-existing periodontal pathology in the radiation field is advised. (BBB)

41451 USE OF LASER RADIATION AS A SURGICAL "LIGHT KNIFE". Fox, John L. (Veterans Administration Hospital, Washington, D. C.). J. Surg. Res., 9: 199-205(Apr. 1969).

The effects of continuous wave (CW) ir (10.6 μ) laser radiation on skin, muscle, skull, brain, liver, and small bowel was carried out on 24 dogs. About 30 w of power focused to a 2-mm diameter spot size readily cut through skin and muscle without significant bleeding. When vessels more than 1 mm in dia were encountered, bleeding usually occurred since the energy caused vaporization of the vessel wall without sealing off the opening. Such bleeding interfered in attempts to cut through brain and liver. As soon as a film of blood covered the surgical field the laser energy was absorbed by the blood, preventing deeper penetration. The skull bone could be incised down to a depth of about 3 mm at which point charring occurred and further penetration was not practical since the deeper layers could not be exposed to the energy by retraction of superficial layers (unlike soft tissue). Healing of canine abdominal skin wound incisions deteriorated during the sixth to tenth day after laser radiation causing wound edge separation. Healing by secondary intention then rapidly ensued. Gross and histologic examination of knife and laser wounds during the first week and during the third through the sixth week failed to reveal significant differences. A preliminary study with the blue-green Ar laser beam showed that similar skin incisions could be made, but the edge of the incision became hard and brittle. The Ar laser energy effect on the brain appeared different also: the brain tissue was much more readily liquefied and thus easily removed by suction. This phenomenon did not occur with the Ir laser, which caused the brain to become firmer and charred. (BBB)

41452 INVESTIGATIONS INTO UREA METABOLISM DURING THE GASTROINTESTINAL SYNDROME AFTER WHOLE BODY IRRADIATION. Gerber, G. B.; Remy-Defraigne, J. (EURATOM, Brussels. Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Z. Gesam. Exp. Med., 150: 33-40(1969). (In German).

Urea metabolism was investigated in mice that were subjected to a whole-body x irradiation with doses causing the gastrointestinal syndrome (3000 R). Urea ^{14}C was injected intraperitoneally and CO_2 collected. The distribution of the radioactivity in the tissues was also followed. The data indicate that urea degradation diminishes in starvation and even more after irradiation. The distribution of activity in tissue and its turnover suggest a more rapid excretion of urea from the first until the third day after exposure, persumably as a consequence of the polyuria. Excretion of urea diminishes, however, and tissue concentration rises shortly before the animals die. (auth)

41453 THE EFFECT OF X-IRRADIATION ON THE MARROW BLOOD VOLUME IN RAT TIBIA. Gong, J. K.; Vertalino, J. E.; Kane, M. J. (State Univ. of New York, Buffalo). Radiat. Res., 39: 277-88(Aug. 1969).

The effects of 2.5 to 1500 R of partial-body exposed to a 250-kVp x-ray on the blood volume of rat tibia were studied at various intervals following exposure up to 10 days. Blood volume of the x-irradiated tibia was compared with that of the x-irradiation-shielded tibia from the opposite side of the same animal by means of ^{131}I–HSA (human serum albumin) or ^{131}I–HSA plus ^{59}Fe–RBC, injected intravenously. Blood volume increases were found for all exposures between 5 and 1500 R. In addition, with the 2.5-R and 5.0-R exposures, significant volume decreases were found during the first 6 hours postirradiation. Two distinct exposure-response relationships were found (between 5 and 50 R, and between 50 and 1500 R) at 24 hours postirradiation. In the lower exposure range, doubling the x-ray exposure resulted in a 5% increase in volume, and in the higher exposure range, doubling the exposure resulted in a 20% increase in volume. It was concluded that the blood volume increases seen in the present study were due primarily to volumetric changes in the marrow sinusoids, a result of sinusoidal dilation with or without massive hemorrhage. (auth)

41454 SPECTRAL ANALYSIS OF THE ELECTRICAL ACTIVITY IN THE CAT'S VISUAL SYSTEM AFTER X-IRRADIATION. Christensen, H. Dix; Smith, William R.; Haley, Thomas J. (Univ. of California, Los Angeles). Radiat. Res., 39: 413-20(Aug. 1969).

Effects of x-irradiation on integrative patterns between EEG activity in different visual system structures were investigated in cats using the method of multiple spectral analysis. The statistical parameters studied were pair-wise coherence, multiple coherence, multiple coherence components, and multiple regression coefficients. Significantly high coherence, reflecting shared activity, was found between the activity in the visual cortex and the lateral geniculate or superior colliculus during photic stimulation but not prior to it. Strong linear activity relationships were found to a lesser extent between the visual cortex and the mesencephalic reticular formation and center median. No mutual activity generally occurred between the hippocampus and the visual cortex. Four hundred roentgen head irradiation had a marked but transient effect on the coherence functions. The lateral geniculate had almost no linearly shared activity with the visual cortex from 1–4 hours post-irradiation. Other structures showed a decrease during this period. While in general no significant coherence levels were found individually with the various structures and the visual cortex, the optimum linear combination of activity as measured by multiple coherence did show a significant value at the flash frequency. (auth)

41455 ULTRASTRUCTURAL CHANGES IN RAT VIBRISSAE FOLLOWING IRRADIATION. I. A GENERAL SURVEY. Pearson, Roger W.; Malkinson, Frederick D. (Univ. of Chicago). J. Invest. Dermatol., 53: 95-106(Aug. 1969).

Rat vibrissae were x-irradiated with 1500 rads, and single hairs were examined by light and electron microscopy. The most striking finding was the development of autophagic vacuoles in the cytoplasm of matrix and sheath cells, beginning as early as one hr post irradiation. The vacuoles incorporated various cytoplasmic structures, and most were gradually converted to dense, relatively amorphous bodies. Presumed remnants of autophagic vacuoles were also present in the keratinizing hair shaft. Tonofilament bundles were focally smaller and fewer in number per cell than normal. Apparently dyskeratotic bundles were present. Nuclear changes were noted only at or near the matrix-papillary junction, and consisted of dense body formation, fine chromatin clumping, and focal rarefaction. The hair appears to be a highly satisfactory organ for ultrastructural analysis of radiation injury. (auth)

41456 DISTRIBUTION OF PROTEIN WITHIN LENSES WITH X-RAY CATARACT. Philipson, Bo (Karolinska Institutet, Stockholm). Invest. Ophthalmol., 8: 271-80(June 1969).

The right eyes of 10-day-old rats were exposed to 500- or 1000-R doses of x rays to induce cataracts. In the lenses irradiated with 1000 R, the first signs of cataract, opacities at the posterior pole, became detectable after about 2 months. On transillumination, weak ringlike opacities in the middle of the cortex were disclosed 1 or 2 weeks later. The first mature cataract was observed after 9 months, and most lenses were totally opaque at 14 months. The rats irradiated with 500 R showed a much slower development of cataract, the first mature cataract being observed after 15 months. Quantitative microradiography enabled the distribution of protein to be determined down to a subcellular level within the lens. Compared to normal lenses, the concentration of protein was reduced in most parts of the cataractous lens, most prominently in mature cataracts. The salient features were sharp, steep gradients in the distribution of protein, usually situated in the peripheral cortex. A close correspondence was present between the position of these protein gradients and that of opacities. Microradiograms of cataractous lenses showed morphological changes in the lens fibers. The physical basis of the opacities in these cataractous lenses is discussed. It is concluded that the main loss of transparency is due to mechanisms of reflection in the steep protein gradients corresponding to interfaces between regions with different refractive indices. (BBB)

41457 ACUTE DEGENERATIVE CHANGES IN THE INNER EAR SENSORY CELLS OF THE GUINEA PIG FOLLOWING LOCAL X-RAY IRRADIATION: A PRELIMINARY REPORT. Winther, Finn O. (Rikshospitalet, Oslo). Acta Oto-Laryngol., 67: 262-8(Mar. 1969).

The inner ear of guinea pigs was x irradiated with single doses of 1000, 2000, 4000, 6000, and 7000 R and the animals were sacrificed 3, 6, 18 hr, and 1 week after irradiation. Investigations were performed by phase contrast microscopy, ordinary light microscopy, and electron microscopy. The organ of Corti and the vestibular end organs showed a characteristic pattern of degeneration. The outer hair cells of the 2 basal coils of the cochlea were extensively damaged, whereas the outer hair cells of the 2 apical coils and the inner hair cells were intact. In the vestibular sensory epithelium the periphery of the cristae and the maculae showed many degenerated cells while fewer generated cells were in the central areas. The nuclei of the outer hair cells of the basal coil of the organ of Corti were coarsely granulated but had retained their shape and size. In animals sacrificed 6 hr following irradiation many of the nuclei of the basal coils were pyknotic. The vestibular epithelium of animals irradiated with 7000 R showed 3 hr following irradiation that some sensory cells of the periphery had coarsely granulated nucleus. In these cells the sensory hair bundles were distorted and often a spiderlike degeneration figure in the cuticular plane was seen. At 6 hr following irradiation all stages of degeneration were observed. (BBB)

41458 MODIFICATION OF URETHAN-LUNG TUMOR INCIDENCE BY LOW X-RADIATION DOSES, CORTISONE, AND TRANSFUSION OF ISOGENIC LYMPHOCYTES. Cole, Leonard J.; Foley, William A. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 39: 391-9(Aug. 1969).

Young adult male LAF_1 mice were given a single (300 R) exposure of x-rays, followed 1 day later by an intraperitoneal injection of urethan, 0.08 mg or 0.2 mg per gram body weight. Cortisone acetate was injected subcutaneously, seven injections of 2.5 mg each, on alternate days beginning 1 day after irradiation. The mice were killed 25 to 26 weeks after the urethan injection, and the enumeration of lung tumor incidence was made by standard procedures. The percentage of mice bearing lung tumors was highest (50%) in the group receiving 300 R plus urethan (0.08 mg/g), as compared with 12.5% in the control mice irradiated only, and 16% in those receiving urethan only. Thus, x-radiation and urethan can be additive for lung tumorigenesis. An increase in lung tumor frequency also occurred when cortisone was administered to 300 R x-irradiated mice (no urethan). Fractionated x-radiation (50 R × 6 given daily) plus urethan (0.2 mg/g) elicited a higher lung tumor frequency than observed in the several appropriate control groups. When the radioprotective compound, AET, was injected into mice just prior to an x-ray dose of 700 R followed 1 day later by a single injection of urethan (1 mg/g), the frequency and mean number of lung tumors were considerably increased over that seen in the control group, receiving 700 R plus urethan, but without AET. Finally, in two separate experiments, the intravenous transfusion of 30×10^6 normal isogenic lymph node lymphocytes 2 days after x-irradiation and urethan treatment, resulted in a significant reduction in the lung tumor frequency. The findings support the thesis that the frequency of occurrence of lung tumors in x-irradiated-urethan-treated mice is the resultant of two separate effects on the specific cells in question: carcinogenic alteration in the cellular genetic material, and sterilization of cell proliferative ability. Ionizing radiation can be additive in lung tumor induction if each is used at low dose levels. A component involving the immune system is involved in urethan lung tumorigenesis. Thus, transfusion of normal isogenic lymphocytes after 300 R plus urethan results in a lower lung tumor multiplicity per mouse; whereas multiple injections of cortisone, an immunosuppressive agent, resulted in increased numbers of lung tumors. (auth)

41459 EARLY EFFECTS OF X IRRADIATION OF THE CEREBELLUM IN INFANT RATS: DECIMATION AND RECONSTITUTION OF THE EXTERNAL GRANULAR LAYER. **Altman, Joseph (Purdue Univ., Lafayette, Ind.); Anderson, William J.; Wright, Kenneth A. Exp. Neurol., 24: 196-216(June 1969).**

The cerebellum of rats was irradiated daily with a 200 R dose of 2 MeV x rays from the day of birth, the number of exposures ranging from 1 to 10. The animals were killed 2 and 24 hr and 4 days after the last exposure, and at the ages of 8 and 10 days. The cell population of the external granular layer was drastically reduced 24 hr after irradiation with a single dose of 200 R, and it was subtotally and maximally destroyed 24 hr after the second exposure. In animals exposed up to 5 × 200 R, recovery of the external granular layer was evident 4 days after the last irradiation; the extent of recovery was inversely related to the number of doses received. The width of the external granular layer was normal or supernormal by 10 days of age in all these groups, though planimetry showed that the total area occupied by this proliferative matrix was subnormal (owing to decreased surface area of cerebellum) and it was inversely related to the number of doses received. After a delay the recovered cells differentiated and led to the development of the molecular and internal granular layers. Several abnormalities were noted in the morphology of the developing cerebellar cortex after exposure to a higher number of x-ray doses, such as abnormal folding of the cerebellar cortex and the massing and disoriented growth of Purkinje cells. Explanations were offered for these effects. (BBB)

41460 AN EVALUATION BY ALPHA-PARTICLE BRAGG PEAK RADIATION OF THE CRITICAL DEPTH IN THE RAT SKIN FOR TUMOR INDUCTION. **Heimbach, Richard D.; Burns, Fredric J.; Albert, Roy E. (New York Univ., N. Y.). Contract AT(30-1)-2785. Radiat. Res., 39: 332-44(Aug. 1969).**

The production of skin tumors and chronic follicle damage in the rat was determined following graded single doses of 37-MeV alpha-particle radiation in two depth-dose patterns: with the Bragg peak placed at each of three depths in skin corresponding to the regions above, below, and at the tips of the resting hair follicle and with the alpha beam modified to produce a linear depth-dose pattern. Dissimilar dose-response curves for tumors and atrophic follicles were obtained for the various depth-dose patterns when the dose was expressed in terms of the maximum dose to either the skin or the follicles or as the average follicle dose. However, the dose-response curve for all the irradiation patterns became congruent when the dose was expressed as the minimum dose to the hair follicles. The results suggest that the production of chronic follicle injury and tumor induction depends on inflicting radiation damage to the entire hair follicle and that the minimally damaged region, regardless of its location, controls the overall response. (auth)

41461 THE EFFECT OF IRRADIATION ON THE LEUKOCYTE ALKALINE PHOSPHATASE. 3. CHANGE FOLLOWING A SINGLE WHOLE-BODY NEUTRON IRRADIATION. **Kobayashi, Hiroo (Jikei Univ., Tokyo). Tokyo Jikeikai Ika Daigaku Zasshi, 82: 646-57(Sept. 1967). (In Japanese).**

Following whole-body irradiation of rats with thermal neutrons of less than 400 rem, measurements were made of leukocyte alkaline phosphatase. Numbers of leukocytes decreased in proportion to the radiation dose. Doses of 100 and 250 rem caused an increase in the alkaline phosphatase. A dose of 400 rem caused an initial decrease, and a later increase in the alkaline phosphatase. (NSA of Japan)

41462 ELECTRON MICROSCOPIC STUDY OF ADRENAL MEDULLARY CELLS OF RATS FOLLOWING WHOLE BODY X-IRRADIATION. **Sekiyama, Shigetaka; Iwai, Yuko; Amitani, Ziro (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 10: 8-16(Mar. 1969).**

Electron microscopic study on adrenal medullary cells of rats after whole body x-irradiation was made. Adult male rats of the Donryu strain, weighing 150–170 g, were irradiated with x-ray (700 R), and the rats showing a lowering of blood pressure were killed at 72 hours after irradiation. Two types of medullary cells, active and degenerated type, were observed in the irradiated rats. The degenerated cells were more numerous than the active cells, and the former showed mitochondrial swelling, dilated cystic rough-surfaced endoplasmic reticulum and abundant ribosomes. There was found almost complete depletion of catecholamine granules. On the contrary, the active cells had numerous ribosomes, abundant rough-surfaced endoplasmic reticulum, many vacuoles, and exhibited a moderate decrease in number of catecholamine granules. These results suggest that an exhausted condition of medullary cells appeared after hyperfunction due to sympathetic stimulation following whole body x-irradiation and the relationship between lowering blood pressure and degeneration of medullary cells was correlative. (auth)

41463 STUDIES ON TIME FACTORS IN IRRADIATION FACTORS IN DOSE FRACTIONATION ON LETHAL EFFECTS ON MICE. **Kawano, Sachiko (Tokushima Univ., Japan). J. Radiat. Res., 10: 25-35(Mar. 1969).**

The relationship of time factors (number of fractions, dose per fraction and intervals between fractions) and the lethal effects on mice was examined by fractionated whole-body irradiation by changing the number of fractions and the dose per fraction with a constant average dose per day, by changing the dose per fraction with a constant interval between fractions, and by changing the intervals between fractions with a constant dose per fraction. When a fixed average dose per day was given, irradiation with a large dose per fraction and small number of fractions was found to be more lethal than that with small dose per fraction and large numbers of fractions. When the irradiation was given with a constant interval between exposures, the total dose necessary for 50% mortality increased with increasing dose per fraction in a range from 100 R to 600 R. When the irradiation was given with constant dose per fraction and different intervals between fractions, a decrease in lethal effects was observed with increasing intervals between exposure. (auth)

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Refer also to abstract 41258, 41268, 41281, 41287, 41289, 41296, 41307, 41317, 41331, 41333, 41345, 41346, 41352, 41357, 41358, 41361, 41363, 41364, 41367, 41395, 41400, 41401, 41410, 41412, 41414, 41415, and 41417.

41464 (ACRH-1000-129) ACCIDENTAL RADIOGOLD (^{198}Au) LIVER SCAN OVERDOSE WITH FATAL OUTCOME. **Baron, Joseph M.; Yachnin, Stanley; Polcyn, Robert; Fitch, Frank W.; Sturner, W. Q. (Chicago Univ., Ill. Dept. of Medicine. Chicago Univ., Ill. Dept. of Radiology. Chicago Univ., Ill. Dept. of Pathology. Argonne Cancer Research Hospital, Chicago, Ill.). [1969]. Contract AT(11-1)-69. 8p. (CONF-690509-2; SM-119/39). Dep. CFSTI.**

From Symposium on the Handling of Radiation Accidents, Vienna, Austria.

A case of a 73-yr-old woman accidentally given 200 millicuries instead of 200 microcuries of ^{198}Au (intravenous) for a liver scan is presented. In 69 days she died of hemorrhagic complications related to thrombocytopenia. Whole-body counting at 30 hr post-injection showed a distribution of isotope consistent with uptake of colloidal material by an abnormally extensive reticuloendothelial marrow. The estimated doses to key target organs were: bone marrow, 440 rads; intestine, 60 to 600 rads; liver, 7300 rads; and spleen, 7300 rads. These figures predicted clinical difficulties involving the bone marrow and liver. Treatments administered included isolation and protective measures, androgens, corticosteroids, infusions, and whole blood transfusions. In spite of these measures, marked thrombocytopenia and petechiae, intermittent hematuria, and subconjunctival hemorrhage persisted. Daily blood counts showed a rapid fall of absolute lymphocyte and granulocyte counts with later partial recovery. Platelet levels fell somewhat later without evidence of recovery at the patient's expiration. Post mortem findings are given. An extensive discussion of the findings in relation to those expected and to the previous history of the patient is presented. The similarity of the pattern of retention and the chemical interness of the colloidal gold particles to Thorotrast is pointed out. However, since ^{198}Au is a β and γ emitter with a very much shorter physical half life, the dose results in acute as well as chronic sequelae. (C.O.)

41465 (COO-1784-16) A STUDY OF THE PHYSIOLOGICAL FUNCTION AND HISTOLOGICAL CHANGES IN THYROIDS IRRADIATED WITH RADIOACTIVE IODINE. Progress Report, July 1, 1968–June 30, 1969. Dobyns, Brown M. (Case Western Reserve Univ., Cleveland, Ohio). Contract AT(11-1)-1784. 6p. Dep. CFSTI.

Data collected on selected patients treated with ^{131}I for hyperthyroidism were examined for evidence of individual differences in reactions to therapeutic doses of ^{131}I. The carcinogenic effects of radiations from ^{131}I were studied in rat thyroids using ^{3}H-thymidine and autoradiography to identify changes in mitosis in cells that may lead to the onset of neoplasms. Autoradiograms of thyroid glands from rats of various ages given various doses of ^{131}I at various times before sacrifice were examined for evidence of thyroid hypertrophy. The results suggest a narrow margin between the amount of ^{131}I that will promote abnormal cell division and the dose that will prevent cell division. Chromosome aberrations were studied in circulating leukocytes of human patients at various times following the administration of doses of ^{131}I varying from five to 167 mCi. Observations made on the incidence of thyroid nodules in children born to Marshallese women exposed to fallout from the detonation of a thermonuclear device in 1954 and on children in Utah and Nevada exposed to fallout in 1954 are discussed. (C.H.)

41466 (ORINS-53) MEDICAL DIVISION RESEARCH REPORT FOR THE YEAR ENDING DECEMBER 31, 1965. (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). 160p. Dep. CFSTI.

41467 (RLO-1781-10) STUDY OF IRRADIATION EFFECTS ON THE HUMAN TESTIS: INCLUDING HISTOLOGIC, CHROMOSOMAL AND HORMONAL ASPECTS. Comprehensive Progress Report, 1963–1969. Paulsen, C. Alvin (Washington Univ., Seattle. School of Medicine). Apr. 14, 1969. Contract AT(45-1)-1781. 91p. Dep. CFSTI.

The following are brief summaries of the data reported in each of the nine sections presented in this comprehensive report. Seminal fluid sperm concentration represents the most critical endpoint available for assessing changes in sperm production following irradiation. Several mathematical models were developed to deal with the data from the examination of irradiated seminal fluid. Histological examinations of testicular biopsies from normal and irradiated subjects up to 1540 days post irradiation indicated that no permanent damage had occurred following x irradiation. There were variations in the extent of injury relating to dose, but by day 1540, complete histological recovery was documented. Biopsies of testicular tissues were analyzed for mitotic chromosomal damage following x irradiation of the testis in human subjects. The data presented support the concept that irradiation of tissues produced chromosomal abnormalities. Studies on meiotic chromosomal damage following x irradiation are not completed. Changes in FSH excretion titers following x irradiation were studied. The data indicated that the post-irradiation time required for an increase in FSH titer was inversely proportional to the radiation dose. The duration of elevated FSH titer also seemed to be dose related. A preliminary study of Leydig cell function following graded doses of x irradiation to the human testis indicated that prior to 7 weeks no changes occurred. However, after 7 wks following 50 R a small rise in serum LH titer was detectable indicating that Leydig cell function was compromised. The elevated serum LH levels indicated a compensatory increase presumably to restore testosterone levels to normal. In another preliminary study it was determined that biopsy, as well as x irradiation, initiated an antigen-antibody reaction. This may explain the decreases in sperm counts following testicular biopsy. Information on the status of the inmate volunteers, the trainees involved in the program and the degrees awarded during 1963 to 1969 is presented. (E.R.B.)

41468 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1970. PART 3. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, FIRST SESSION ON BIOLOGY AND MEDICINE; ISOTOPES DEVELOPMENT; SPECIAL NUCLEAR MATERIALS; NAVAL PROPULSION REACTORS; COMMUNITY; PROGRAM DIRECTION AND ADMINISTRATION; SECURITY INVESTIGATIONS; TRAINING, EDUCATION, AND INFORMATION; RAW MATERIALS; AND LIGHT WATER BREEDER REACTOR, APRIL 29 AND 30, 1969. Washington, D. C., Joint Committee on Atomic Energy, 1969. 777p. GPO $3.25.

Specific accomplishments and future plans of the Biology and Medicine program are described in the statement in support of the fiscal year 1970 authorization bill. Research on somatic effects of radiation is organized with the objective of recognition of early and delayed effects of radiation. Research on human populations includes the following: survivors of the bombings of Hiroshima and Nagasaki; the Rongelap people exposed to fallout; survivors of nuclear criticality accidents; patients therapeutically exposed to total body irradiation; persons with internally deposited radium and mesothorium; workers occupationally exposed to low doses of external radiation; and patients exposed to Thorotrast in the course of diagnostic radiography. Other aspects of the program include radiation genetics, molecular and cellular level studies, environmental radiation studies, atmospheric radioactivity, radiological health physics and instrumentation, chemical toxicity, nuclear energy civil effects, cancer research, and radiation preservation of foods. (H.L.W.)

41469 THE 5-YEAR CURE OF MALIGNANT EYELID TUMORS AFTER RADIOTHERAPY. Vollmar, R.; Lommatzsch, P.; Lommatzsch, K. (Humboldt-Univ., Berlin). Klin. Monatsbl. Augenheilk., 154: 486-96(Apr. 1969). (In German).

Irradiation injuries were observed after radiotherapy of various types of eyelid tumors with x irradiation or Ra. In 24 patients treated by Ra implantation, four lens opacities and two symblepharons were observed. Minor atrophies of the lids, telangiectases, depigmentation, or epilation of the eyelashes were not observed as results of the irradiation treatments. In the patients treated with fractionated x irradiation that totaled 6500 to 7000 R, there were observed two ptoses, one radiation cataract, and one symblepharon. However, in some cases, it was found that leukomeladerma, atrophy of the skin of the eyelid, and telangiectases may develop several yr after irradiation. It was found that prophylactic irradiation treatment after surgery was inadvisable. (BBB)

41470 RENAL ATROPHY WITHOUT HYPERTENSION FOLLOWING ABDOMINAL IRRADIATION IN INFANTS AND CHILDREN. Sagerman, Robert H.; Berdon, Walter E.; Baker, David H. (Columbia-Presbyterian Medical Center, New York). Ann. Radiol., 12: R278-84(1969). (In French and English).

From European Society of Pediatric Radiology, Hamburg, Germany. See CONF-680552.

The pyelographic changes in six survivors of neuroblastoma following renal irradiation are presented. All four receiving unilateral renal radiotherapy showed changes, ranging from cessation of growth to progressive atrophy. No renal change occurred in one of two patients treated to both kidneys; the unilateral change in the other may be due to the effects of direct tumor infiltration. None of the six developed hypertension. (auth)

41471 TRAUMATIC SKIN CARCINOMAS. Hess, P. Berufsdermatosen. Occupational Dermatoses, 16: 249-60(Oct. 1968). (In German).

A detailed discussion of cases of accident and occupational carcinomas treated during the past few years is given. The latent periods vary from 1 month to 33 years for accident carcinomas so far as concerns the traumatic group. Consideration must be given to associated causes when a cancer develops at the site of an accidental injury. In one case of somatic irradiation injury, 43 years elapsed between exposure and the appearance of symptoms, showing that no limit can be set to the latent stage. Occupational carcinomas were detected only in coalmine and tar factory workers. Lesions are difficult to cure, even after change of occupation. The decisive importance of careful washing after work is pointed out. (Occup. Safety and Health Abstr.)

41472 TREATMENT OF THYROTOXICOSIS. McGirr, E. M.; Greig, W. R. (Royal Infirmary, Glasgow). Practitioner, 200: 485-93(Apr. 1968).

The hazards, particularly hypothyroidism, encountered in treating hyperthyroidism with ^{131}I and by other methods are reviewed. Fears that radioiodine would lead to an increased incidence of neoplasia in the thyroid are unsubstantiated in adults; nor have there been more cases of leukemia than would have been expected by chance. The only serious complication of radioiodine therapy is a substantial incidence of hypothyroidism at the end of 10 yr. There is evidence that further cases may be expected even after this interval. Accordingly it is necessary to follow up radioiodine-treated patients for a long time. Attempts made to explain the hypothyroidism and the delay in its appearance are discussed. Some thyroid epithelial cells seem to continue to function for some time after irradiation but lose their reproductive capacity and eventually die. As a consequence the number of cells producing hormone gradually falls and hypothyroidism occurs sooner or later. Attempts are being made to modify radioiodine therapy, to reduce the incidence of hypothyroidism without increasing the prevalence or the duration of the uncontrolled thyrotoxic state. The radiation dose from radioiodine is reduced from 7000 to 3500 rad, and is supplemented with courses of antithyroid drugs. The incidence of hypothyroidism is substantially reduced but many patients, as high as 40% at 2 yr, are still dependent on drugs. Pregnancy is an absolute contraindication to radioiodine therapy. Estimation of the dose of radioactivity required by each patient involves theoretical difficulties because of the error in determining the size of the thyroid gland. Most difficult is prescribing appropriate doses for patients with very large goiters, often a relative contraindication to radioiodine therapy. (BBB)

41473 RADIATION-INDUCED CHANGES IN MEDICAL PERSONNEL WORKING WITH X RAYS. Lada-Jagas, Romana; Jarczyk, Domyslaw. Wiad. Lek., 21: 771-4(May 1, 1968). (In Polish).

Two cases of radiation-induced changes caused by overdosage of ionizing radiation in x-ray technicians are discussed. These cases illustrate the course of radiation-induced changes due to summation of small doses of ionizing radiation (as a result of damage to an apparatus for radiophotography in case one and during everyday work with x rays in case 2). (auth)

41474 LATE CEREBRAL RADIONECROSIS WITH HYPERTENSIVE ENDOCRANIAL EVOLUTION. Amico, G.; Canger, R. (Ospedale Maggiore, Milan). G. Psichiat. Neuropatol., 95: 533-45(1967). (In Italian).

Observations are reported of retarded cerebral radionecrosis in healthy cerebral tissue, and the hypertensive endocranial evolution which followed röntgentherapy for reticulum-sarcoma of the left frontal sinus was verified. The unusual complexity of the treatment was shown by a syndrome of Foster–Kennedy together with a psychic prefrontal symptomatology and precentral paroxysm disturbances with a neuroradiological outline of expansive process in the anterior cranial fossa. The radiobiological effects on the nerve tissue are then considered, and the possible autoclasic genesis of the affection is mentioned. (auth)

41475 HISTOPATHOLOGIC LESIONS IN THE THYROID GLANDS OF PATIENTS WHO RECEIVED RADIATION TREATMENT ON NECK REGION. Umisa, Hiroyuki; Okada, Tsuneo (Hiroshima Univ.). Hiroshima Daigaku Igaku Zasshi, 16: 937-47(Oct. 1968). (In Japanese).

The radiotherapy, that is used to suppress primary or metastatic malignant tumors of the neck or to repress hyperthyroidism, induces radiation lesions. Histological research was performed on 13 cases of human thyroid gland irradiated internally or externally. Results are as follows. In the case of acute irradiation with ^{131}I, radium, x-ray, or ^{60}Co, the radioinduced lesions, in the acute stage, included damage to the blood vessel, such as thrombosis, and collapse of the follicle followed by necrosis of the follicular epithelial cell, and in the later stage, atrophy of the follicle with fiber around the follicle. In the chronic stage of ^{60}Co γ irradiation, three cases showed infiltration of the lymphocyte. After x irradiation, one case showed nipplelike gland cancer. Such involuted or hyperplastic nodules associated with cancerous changes, and the nipplelike minute adenomas, were observed after exposure to radiation. This fact suggests that in the thyroid gland after radiation lesion, the epithelial cells that underwent changes following irradiation, showed progress to malignancy under the influence of thyroid stimulating hormone. (NSA of Japan)

41476 OBSERVATIONS ON THE EFFECT OF CONTRAST MATERIAL ON NORMAL AND ABNORMAL BRAIN TISSUE USING RADIOPERTECHNETATE. Rosenthall, Leonard; Ambhanwong, Surapong; Stratford, Joseph (Montreal General Hospital). Radiology, 92: 1467-72(June 1969).

Fifty patients were studied for the effects of radiographic contrast medium on normal and abnormal brain tissue with radiopertechnetate as the test agent. The radiopharmaceutical was administered immediately before and after cerebral angiography either through the common carotid, internal carotid, or intravenous route. An increased concentration of radioactivity on the side of angiography was observed, and it is postulated that part of it is a reflection of an alteration of the normal blood-brain barrier. A higher concentration of radioactivity was present in 15 out of 18 lesions detected by conventional scanning methods. This is partially accounted for by a greater effect of the contrast material on the lesion than on the normal blood-brain barrier. No tumor was visualized with the combined study that was not seen with the conventional scan, but this did occur in four cerebral vascular accident lesions. It is yet to be proved conclusively that the contrast material affects normal brain tissue uniformly as far as the radionuclide scan is concerned. Otherwise, focal concentrations of activity may not necessarily reflect the site of damaged brain tissue or neoplasia. Nineteen of the fifty patients were scanned the day after angiography, and false-positive scans were not encountered. (auth)

41477 RESIDENT EDUCATION IN GYNECOLOGIC ONCOLOGY AND RADIATION BIOLOGY. Beecham, Clayton T. (Geisinger Medical Center, Danville, Pa.). Bull. Geisinger Med. Cent. (Danville, Pa.), 21: 40-3(Feb. 1969).

Teaching programs for hospital residents in radiotherapy and radiobiology that will ensure avoidance of radiation hazards are outlined. The training program for a resident should include basic instruction in radiation by a physicist. He must learn the true hazards from exposure to ionizing radiation to the mother and to the fetus, the contraindicated and indicated studies in pregnancy, and hazards in the nonpregnant (including physicians and nurses). Training in radioisotope diagnostic procedures (scanning, placental localization, renograms, blood volume, thyroid studies) should include indications (no other method to obtain similar data) and contraindications (as the thyroid scan in pregnancy). Teaching of radiation therapy should include its uses, abuses, and need for exact measurements; a definite understanding of influences such as distance and shielding on dosage; and the desirable doses for vaginal, cervical, corpus, and ovarian malignant neoplasia. (BBB)

41478 FRACTURES OF THE NECK OF THE FEMUR AND THE PELVIS AFTER X-RAY THERAPY IN CANCER OF THE UTERUS. Taton, J.; Lukawska, K. (Inst. of Oncology, Warsaw). Pol. Med. J., 7: 965-73(1968).

Radiation injuries to the neck of the femur and pelvic bones as complications of x-ray therapy of genital cancer are reviewed, and the authors' experience with 50 patients treated for postirradiation fractures of the neck of the femur and of the pelvic bones in the course of treatment of uterine cancer in 4426 patients is presented. Incidence of radiation injury to the bones after conventional x-ray therapy was 0.7%. The frequency of postirradiation injuries increased with age, being most frequent in women aged 70 or more. Pain in the extremity and walking disability dominated the clinical symptoms. Radiography should be carried out in all women complaining of bone pain after irradiation. In elderly patients a change of the usual method of irradiation of the true pelvis should be considered. The end results of treatment in these patients are favorable notwithstanding severe radiological changes in the bone. In patients with postirradiation bone injuries the rate of cure of uterine cancer is higher than in the other patients treated similarly. (BBB)

41479 RADIATION COMPLICATIONS IN HEAD AND NECK CANCER. Daly, Thomas E. (Univ. of Texas, Houston). Cancer Bull., 20: 90-1(Sept.-Oct. 1968).

Dental examinations were carried out to investigate radiation injury in patients irradiated in the oral region. The sites in the most direct line of radiation included the nasopharyngeal and pharyngeal areas and the oral cavity (tongue, gums, hard and soft palate, buccal mucosa, lips, and tonsillar areas). The aim was to learn whether the incidence of necrosis of the bone and the dental decay, termed radiation decay, can be reduced in cancer patients by using lateral face fields (or lateral portals of entry) of irradiation which cover the salivary glands, predominantly the parotid glands, and to some extent the submaxillary glands. Patients in poor dental health had all remaining teeth extracted. They were treated with antibiotics to lower the incidence of osteomyelitis. Teeth in the direct field of irradiation were removed also in patients with fair dental health. A minimum of 10 days before radiation therapy was required to obtain primary closure and adequate healing. Fluoride was applied daily and continued indefinitely. Patients with good dental health usually had no teeth removed unless there was an isolated, mobile tooth or carious teeth beyond repair. After 2 ½ yr it was found that the patients who had the fewest problems with necrosis of the bone were those in the edentulous and good dental health groups. There was no need for partial mandibular resection to manage bone necrosis after radiation. This was in contrast to 122 resections of the mandible for necrosis performed in an earlier series. The necrosis found in some patients was not as severe as found previously. Treatment for necrosis which occurred after radiation treatment was usually conservative, consisting of the administration of antibiotics, zinc peroxide packs, and minor oral surgical procedures to remove sharp, irregular spicules of bone. There was a drastic reduction in radiation decay in patients who received fluoride 5 min each day. (BBB)

41480 EXTRACORPOREAL IRRADIATION OF BLOOD: A CLINICAL STUDY IN CANDIDATES FOR RENAL TRANSPLANTATION. Rosengren, B.; Bergentz, S.-E.; Hood, B.; Lindahl-Kiessling, K. (Sahlgrenska Sjukhuset, Goeteborg). Scand. J. Urol. Nephrol., 2: 58-61(1968).

The effect of external irradiation on lymphocytes was studied in 11 patients before homologous renal transplantation. They were given extracorporeal irradiation to circulating blood at doses of 9000 to 37,000 rad over 8 to 31 days. Two irradiation techniques were tried. The first employed ^{60}Co for external irradiation and blood was circulating through a plastic tube to get a dose rate of 400 rad/min. The estimated transit dose was 500 to 600 rad. The second technique used an irradiation chamber with β particles from a 2.4-Ci ^{90}Sr source. The blood was passed through the chamber twice through an elongation of the teflon tube used for the arteriovenous shunt. Only 3 patients exhibited a significant decrease in lymphocyte count. No changes were seen in the total white cell count, hemoglobulin, or osmotic fragility of red cells. Morphological changes of the cultivated lymphocytes with pycnosis of the nucleus were observed. Chromosome studies in 3 patients revealed translocation, ring chromosomes, and breaks in the chromosomes. The capacity of the lymphocytes to incorporate ^{14}C-thymidine in vitro after addition of phytohemagglutinin was significantly inhibited in 4 of the 5 patients studied. Following transplantation the clinical course of the irradiated patients was no different from that of patients given conventional immunosuppressive drugs only, except that rejection episodes were less frequent and violent. Relatively high doses were necessary to decrease the lymphocyte count. The irradiation-induced chromosome damage as well as inhibited DNA synthesis were more sensitive indicators of the effect of the treatment. (BBB)

41481 CAUSAL FACTORS IN LUNG CANCER. Med. J. Aust., 1: 773-4(Apr. 12, 1969).

Evidence that ionizing radiation, among other agents, can induce lung cancer is briefly reviewed. The well-known occupational lung cancer of the miners of Schneeburg and Joachmistal may have had at least 3 possible and combined causes, Ni, As, and ionizing radiation. By inserting radionuclide-bearing threads in the lungs of rats, it was found possible to induce highly invasive squamous-cell carcinoma in 30 to 50% of the animals. Interestingly, the exposure level and tumor incidence were comparable to those estimated to have occurred in the Schneeburg and Joachmistal miners. In other experiments it was possible to produce cancer in all of 200 rats with implanted pellets of isotopes. The rats were sacrificed beyond 220 days. The lesions were traced through all stages from the proliferative to the invasive stage. (BBB)

41482 LYSOSOMES AND THE REACTIONS OF SKIN TO ULTRAVIOLET RADIATION. Johnson, B. E.; Daniels, Farrington Jr. (Cornell Univ., New York). J. Invest. Dermatol., 53: 85-94(Aug. 1969).

Changes in lipid in skin exposed to uv radiation indicate that damage to cellular or organelle membranes may occur. Lysosomes are more susceptible to such damage than are mitochondria or plasma membranes irradiated in vitro, and decreased acid phosphatase activity in mouse skin after irradiation in vivo, suggests that lysosome rupture may occur. In the present study, human skin exposed to 10 times the minimal erythema dose was biopsied at varying times from one to 24 hr after irradiation. Sections were examined for lysosomal stability by a technique of differential incubation based on a standard method for the histochemical demonstration of acid phosphatase activity. Changes in activity, an early apparent increase followed by decrease and disorganization of staining while little change in succinate dehydrogenase occurred, are consistent with specific damage to the lysosome membrane with increased permeability leading to complete or partial rupture. Release of the contained hydrolytic enzymes in this manner may explain a part of the pathology of sunburn. (auth)

41483 FACIAL CHANGES DUE TO RADIATION IN CASES OF RETINOBLASTOMA. Malbran, Jorge. Ophthalmologica, 157: 268-73(1968).

Serious complications may occur in the ocular and periocular structures after radiotherapy for retinoblastoma. Two of the less frequent complications, which are referred to here, are: (1) changes in the bones of the face, and (2) the effect on the skin of the irradiated area (temporal and nasal regions). Facial deformities due to irradiation are well known, especially in children treated for neoplasms, but in retinoblastoma the deformities are very characteristic. Generally, children who have received radiation treatment for retinoblastoma show retardation of the growth of the middle face, orbits, and pyramidalis nasi. The result of this retardation is not immediately noticeable as the process is slow and progressive. It becomes more obvious in adolescence, despite the fact that treatment was carried out in early childhood. This atrophy gives a unique appearance to the face; it is found often in irradiated patients and causes different individuals to look almost as if they were twins. The middle portion of the face, including orbits and pyramidalis nasi, becomes shorter and narrower, with reduction of the vertical dia of the orbits and length of the nose. As the frontal bone and nasal cartilages are not irradiated, their growth is normal and this gives prominence to the frontal view of the face. The tip of the nose and the nasal alae remain broad and out of proportion, while the bridge becomes depressed and acquires a characteristic dent and, in some cases, osteonecrosis of the irradiated parts may be present. The skin changes in the irradiated areas (temporal region) may be typical radiodermatitis with no other special feature, followed by the loss of hair in the affected region. These changes generally clear up without leaving any sequelae but in more serious cases the nasal and temporal areas show narrowing and atrophy with typical radiation dermatitis as well as keratosis and telangiectasis of the small veins. The atrophic areas are firmly adherent to the underlying bone. Two cases are illustrated. (BBB)

41484 EPIDEMIOLOGIC ASPECTS OF CANCER. MacMahon, Brian (Harvard Univ., Boston). CA - Cancer J. Clin., 19: 27-35(Jan.-Feb. 1969).

Ionizing radiation and other environmental carcinogenic agents are reviewed in terms of cancer epidemiology. There is no question now but that large doses of ionizing radiation are leukemogenic in man. The exposed populations that have a demonstrated susceptibility to leukemia (Japanese survivors of the atomic bombings, patients treated with x rays for ankylosing spondylitis, American and British radiologists, infants irradiated for thymic enlargement, patients receiving injections of Thorotrast) are so varied that their radiation exposure is the only common factor to which their increased risk can reasonably be attributed. The leukemia cell types that are increased include the acute leukemias and chronic myelocytic leukemia; chronic lymphocytic leukemia is not associated with radiation exposure. The risk reaches a peak 4 to 8 yr after exposure; however, it remains higher than normal for at least 15 yr and perhaps much longer. Risk increases with dose of radiation received. Data from atomic bomb survivors and ankylosing spondylitis patients give an estimated risk of 1 to 2 cases of leukemia per yr per million population exposed for each rad of exposure. Thus, 1000 persons exposed to 500 rad would be expected to have $\frac{1}{2}$ to 1 case of leukemia annually, or 5 to 10 cases in the subsequent 10 yr. This formula gives a reasonable approximation to the data for exposures between 100 and 1500 rad. It is not known whether a similar linear relation exists at lower doses or whether there is a threshold below which leukemia risk is not increased. Squamous carcinoma of the lung in some miners is now attributed to exposure to radioactivity from breakdown products of uranium. Over 50 cases of lung cancer have been reported in the last decade in about 3500 underground workers, and a clear relation has been demonstrated between lung cancer risk and duration and severity of exposure to radioactivity. Bone cancer from Ra ingestion and skin cancer from x-ray exposure are also cited. (BBB)

41485 CARCINOMA OF THE THYROID IN CHILDREN. Exelby, Philip E.; Frazell, Edgar L. Surg. Clin. N. Amer., 49: 249-59 (Apr. 1969).

In an analysis of 62 cases of thyroid cancer in children under the age of 16, there were 13 with a positive history of previous irradiation to the head and neck area, 10 to the thymus gland, 1 to the neck for cervical adenitis, 1 to the adenoids, and 1 to the orbit for retinoblastoma. In all reported cases, the doses varied between 180 and 6000 R, with a mean of 600 R. The interval between exposure to radiation and the development of thyroid cancer varied from 3.6 to 15 yr, with a mean interval of 8.7 yr. Other reports of radioinduced thyroid carcinoma are reviewed, and experimental and clinical evidence for this etiologic relation is assessed. Rats fed methylthiouracil (MTU) and radioiodine, or those given MTU and external radiation, develop thyroid cancer. External radiation or radioiodine alone does not produce cancer, nor does MTU alone. A large clinical study has followed 2878 persons who received thymic irradiation in infancy. The incidence of thyroid cancer in this group (0.7%) is $\sim$700 times that in the general population. One subgroup of 268 patients who received a mean dose of 353 R had a 30% incidence of thyroid nodularity and a 4.3% incidence of thyroid cancer. Another study noted that 38% of thyroid cancer patients had received previous irradiation to the thyroid region. Most had had irradiation to the thymus in infancy, but there were many who had been treated for enlarged tonsils and adenoids, hemangiomas, nevi, acne, eczema, or cervical adenitis. In a third survey, of 15 patients with childhood thyroid cancer, every one gave a history of x-ray therapy in infancy for various benign conditions. (BBB)

41486 MYXEDEMA AFTER RADIOTHERAPY TO THE NECK AND SUPRACLAVICULAR REGION. Marcussen, Julius M. (Diakonissehusets Sykehus, Oslo). Nord. Med., 80: 1622-3 (Nov. 28, 1968). (In Norwegian).

Two cases of hypothyroidism that developed after external irradiation of the neck and supraclavicular region are reported. This generally assumed rare complication may be more common than is realized. Two women developed myxedema after operation and therapeutic irradiation for carcinoma of the breast. The intervals between radiotherapy and diagnosis was 6 months and 3½ yr, respectively, though in the latter case symptoms appeared within 1½ yr. The first patient, a 49-yr-old woman had received a total of 600 R of x-ray exposure over the neck region. The second patient, a 45-yr-old woman, had been given a 9000-R dose over the thoracic and axillary region of ^{137}Cs γ radiation, with the supraclavicular area receiving 4400 R. In the first case the symptoms appeared 4½ months after additional small doses of x irradiation were given to the cervical region for spondylytic pain. It is suggested that minor radiation damage to the thyroid gland may cause myxedema in patients with pre-existent thyroid hypofunction. (BBB)

41487 CHROMOSOME STUDIES ON PATIENTS WITH POLYCYTHEMIA VERA. Nagy, G.; Yurgutis, R. P. (Univ. Medical School, Debrecen, Hungary). Haematologia (Budapest), 2: 179-86(1968).

The possibility that ^{32}P treatment of polycythemia vera may induce chromosome changes was evaluated in 12 patients. Nine had suffered exacerbations of the disease and in 3 secondary myelofibrosis had developed. Prior to the chromosome studies in the exacerbation group, 5 patients had been treated only with venesection or with venesection and As. The remaining 4 patients had been given several doses of ^{32}P; the average total dose amounted to 22 mCi and the highest total dose was 41 mCi. In the exacerbation group the duration of the disease varied from 1 to 16 yr in patients treated with ^{32}P from 4 to 16 years. Polycythemia vera had progressed to myelofibrosis in 2 patients at 1 yr, in a third patient 4 yr before the present experiments. These 3 patients had been repeatedly subjected to treatment with radiophosphorus, total doses amounting to 12, 26, and 28 mCi. All had developed pronounced splenomegaly with myeloid metaplasia. Independently of the duration of the disease and of the therapy used, normal chromosome pictures were obtained for all the 9 patients in the exacerbation stage. Normal chromosome pictures were found for 2 of the 3 patients with secondary myelofibrosis. Aneuploidy was found in only 1 of these patients. Although 7 out of the 12 patients were repeatedly treated with ^{32}P, no ring chromosomes suggesting radiation damage or any other abnormality that could be ascribed to radiophosphorus treatment was found in the chromosome pictures. No leukemia transformation occurred in any of the patients. No other symptoms suggesting radiation damage were found. (BBB)

41488 POSTIRRADIATION MALIGNANT NEOPLASMS OF THE UTERINE FUNDUS. Thomas, William O. Jr.; Harris, Homer H.; Enden, James A. (Univ. of Oregon, Portland). Amer. J. Obstet. Gynecol., 104: 207-19(May 19, 1969).

Sixteen cases are described in which uterine tumors developed after radiotherapy (an average of 11.8 yr later). Irradiation had been used for benign conditions in 5 cases and for squamous carcinoma of the cervix in 11. There were 11 adenocarcinomas of the endometrium, 3 carcinosarcomas, and 2 mixed mesodermal tumors. The youngest patient was 39 and the oldest 68. The average age was 54.7 yr. After irradiation, all patients were postmenopausal. The time between irradiation and the development of the uterine malignant neoplasm ranged from 2 to 25 yr. The only case of a relatively short interval (2 yr) was included because at the time of irradiation the endometrium was definitely proliferative and normal. Prior to the original irradiation, abnormal bleeding was the presenting symptom. The relative rarity of postirradiation malignant neoplasms compared to the number of the patients receiving radiotherapy suggests other factors may also be involved. Five of the patients in this series received estrogens for 10 yr or more. Irradiation may only be a contributing factor in an individual who already has a tendency toward uterine endometrial malignant neoplasm because of endogenous irregularities of the endocrine system. It was impossible to draw any definite conclusions as to etiology from a series as small as this. (BBB)

41489 PICTURE OF KERATINOCYTES AFTER SKIN IRRADIATION WITH ULTRAVIOLET RAYS. Szadurski, J. A. (Main Research Center of the Railway Health Service, Warsaw). Pol. Med. J., 8: 494-6(1969).

Translated from Przegl. Dermatol., 55: No. 6, 1968.

As early as on the 4th day, and especially distinctly on the 18th day after uv irradiation with a quartz lamp, kerantinocytes of the epidermal surface of human skin was found to exhibit changes evidencing an incomplete reconstruction of formed cell elements in the course of process of keratinization. These changes, visible in preparations of Gram-stained epidermal strippings probably occur as a result of a shortening of the time of the passage of cells from the germinative layer to the skin surface. (auth)

41490 TETANY AFTER RADIOIODINE TREATMENT FOR HYPERTHYROIDISM. Hartemann, P.; Leclere, J.; Duc, M.; Schweitzer, M.; Puchelle, J. C. (Univ., Nancy). Ann. Endocrinol. (Paris), 30: 77-85(Jan.-Feb. 1969). (In French).

Three cases of tetany resulting from ^{131}I treatment of hyperthyroidism are reported. The clinical, biological, and electrical symptoms of tetany in hyperthyroid patients, before and after the therapeutic administration of radioiodine, are described. The total dose of radioiodine given varied between 4 and 30 mCi. Only 11 patients out of 100 developed hypothyroidism as a result of ^{131}I treatment, so that the complication of tetany is much rarer (3 cases). Tests with disodium ethylenediaminetetraacetate (EDTA) were normal in 25 patients before ^{131}I treatment of hyperthyroidism. In 6 cases the electromyogram became abnormal after ^{131}I treatment. It is suggested that ^{131}I was in fact responsible for the post-treatment tetany. In one case it was possible to trace the development of tetany after ^{131}I administration. Although chronic tetany after radioisotope treatment is rare, patients often suffer temporary neuromuscular disorders with significant abnormalities in the electromyogram. These transient symptoms of primary tetany are perhaps related to an abnormal temporary secretion of thyrocalcitonin. However, irradiation of the parathyroid glands in an abnormal situation in relation to the thyroid remains the most satisfactory explanation of the rare postirradiation cases of chronic tetany. (BBB)

41491 ENVIRONMENTAL RADIATION STUDIES AND PRECAUTIONARY MEASURES ON THE HIGH ALTITUDE COSMIC RAYS: FISSION PRODUCTS FROM NUCLEAR DETONATION AND AIRCRAFT EQUIPMENT. 4. GENERAL CONSIDERATION, BIOLOGICAL EVALUATION, AND PRECAUTIONARY MEASURES ON THE SUBJECTS OF AIRCRAFT ENVIRONMENTAL RADIATION. Naba, Katsumi (Keio Univ., Tokyo). Keio Igaku, 46: 47-54(Jan. 1969). (In Japanese).

Total radiation exposure of Japanese pilots from cosmic rays, fission debris, and radioactive selfluminous paints was estimated to be 610 to 866 mRem/960 hrs during the year for an altitude of 30,000 ft. The most important precautionary measures discussed concerning radiation safety are protection against radioactive contamination for jet pilots and maintenance people. The surface contamination of jet aircraft for radioactive dust sampling reached over $10^{-3}\ \mu$Ci/cm^2 on the wing after 5th Red China nuclear detonation. To protect against potential radiation hazard, the aircraft that were contaminated over $10^{-3}\ \mu$Ci/cm^2 should be isolated in the radiation control area, and should be decontaminated until the levels of radioactivity are under $10^{-4}\ \mu$Ci/cm^2. The inhibitory effects of Ca, Mg, PO_4, on the deposition of ^{90}Sr in bone were investigated by bone metabolism studies of rats using calcium phosphate, glycerocalcium phosphate, magnesium sulphonate, and magnesium oxide administration in feeding. ^{90}Sr deposition in bones was decreased by intestinal administration of Ca, Mg, and PO_4 compounds. (NSA of Japan)

41492 ELECTRON MICROSCOPIC STUDY OF TONSILLAR RETICULOSARCOMAS. 2. EFFECT OF RADIATION ON TUMOR CELLS. Kato, Sumihiko (Tokushima Univ., Japan). Tokushima J. Exp. Med., 14: 155-76(Nov. 1967).

The left tonsil of a 78-year-old female patient was irradiated by ^{60}Co γ-rays with a total dose of 5000 R for about 70 days. The effect of the irradiation on tumor cells was studied observing the change of micro-structure of cells with the electron microscope. The results obtained are as follows: The external morphology of the cell membrane of irradiated tumor cells was very complex, and characterized by the presence of giant cytoplasmic protrusions. The cells that exhibited active fibrosis in the periphery showed the presence of many pinocytotic vacuoles which were not observed before the irradiation. The changes in the nucleus included the intense bulge of outer nuclear membrane and the sparse distribution of intranuclear particles. The reticular structure of nucleolus became indistinct. The incidence of giant nucleoli was low. Some mitochondria swelled and the others contracted, and this was one of the most intense changes appearing after the radiotherapy. The vacuolar smooth surfaced endoplasmic reticulum swelled and became larger. The rough surfaced endoplasmic reticulum was very sparse. The content of lipids, lysosomes, and myelin was decreased after the irradiation. Many inclusions with a limiting membrane, interpreted to be formed by denaturation, appeared. Fine filaments were observed within the tumor cells, and also a similar fibrous structure with striae at regular intervals emerged around the cells. (NSA of Japan)

41493 GASTRIC ULCERATION FOLLOWING COBALT TELETHERAPY. ESTIMATION OF THE TOLERANCE DOSE. Sylven, B.; Vikterloef, K. J.; Schnuerer, L.-B. (County Hospital, Oerebro, Sweden). Acta Radiol., Ther., Phys., Biol., 8: 183-8(June 1969).

Two cases of gastric ulceration following external high-energy irradiation are reported. The vascular and cytologic changes in the mucosal cells made a distinction possible between irradiation-induced and common ulcers. The tolerance dose of the mucosa in the pyloric region may be estimated to about 4,300 ± 10% Rad given over 5 weeks. (auth)

41494 TRIIODOTHYRONINE UPTAKE TEST IN GYNECOLOGIC RADIATION THERAPY. Laakso, L.; Nikkari, T.; Groenroos, M. (Univ., Turku, Finland). Acta Radiol., Ther., Phys., Biol., 8: 189-92(June 1969).

Gynecologic radiation therapy may cause small changes in the triiodothyronine uptake. An initial significant increase is followed by a significant decrease to values lower than those before therapy. The reason for this and the significance of the changes are discussed. (auth)

41495 SIGNIFICANT FACTORS IN RED CELL MASS CHANGES AFTER FRACTIONATED LOCAL RADIOTHERAPY. Levitt, S. H.; Brandt, E. N. Jr.; Bogardus, C. R. Jr. (Univ. of Oklahoma, Oklahoma City). Acta Radiol., Ther., Phys., Biol., 8: 199-207(June 1969).

In sixty patients treated with fractionated local irradiation to the head and neck, thorax, and pelvis, serial studies with determination of the venous hematocrit, computed hematocrit, red cell mass, plasma volume, total blood volume and estimated blood volume were performed. A significant decrease in red cell mass during treatment, apparently due to irradiation, was only noted in patients receiving thoracic irradiation. This was related to field size, but not to dose. The possible reasons for this phenomenon are discussed. (auth)

41496 LONG-TERM EFFECTS OF HYPERBARIC OXYGEN AND IRRADIATION ON NON-NEOPLASTIC TISSUES. Churchill-Davidson, I. (St. Thomas Hospital, London). pp 134-40 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

The damage to normal tissue resulting from use of hyperbaric O_2 with irradiation is reported. Radionecrosis of the laryngeal cartilage developed in 16 out of 94 patients treated with total doses greater than 4500 R of ^{60}Co γ radiation. No increase in bone damage was reported. Skin damage after doses of 1000 to 1500 R was minor with mild first or second degree erythema. Oral mucosal reactions were variable, with some dryness, and healing was sometimes delayed. A radionecrotic ulcer developed at the site of a biopsy scar in 1 case. The incidence of subcutaneous fibrosis was ~1% after irradiation in air or in O_2. Bowel damage and severe pelvic fibrosis were observed only in patients treated for bladder carcinoma, but none developed in several cases of cervical carcinoma. Out of 56 patients 3 developed small bowel obstruction, of which 2 became perforated, 2 developed large bowel obstruction, and 3 developed severe pelvic fibrosis. Of these, 2 received excessive doses of irradiation. No brain damage was observed in 8 cases, but 8 cases of spinal cord myelitis developed among 120 treated patients. The cervical cord was involved in 6, and the mid-dorsal cord in 2 patients. Lung fibrosis and late eye damage was not observed. (BBB)

41497 CLINICAL ASPECTS OF HYPERBARIC OXYGEN AND RADIOTHERAPY: NEW YORK EXPERIENCE. Chang, Chu H.; Seaman, William B.; Jacox, Harold W. (Columbia-Presbyterian Medical Center, New York). pp 183-8 of Frontiers of Radiation Therapy and Oncology. Vol. I. Vaeth, Jerome M. (ed.). New York, S. Karger, 1968.

From 1st Annual Conference on Hyperbaric Oxygen and Radiation Therapy of Cancer, San Francisco, Calif. See CONF-651158-(Vol.1).

Complication rates in patients irradiated with 24-MeV x rays under hyperbaric O_2 at 3 or 4 atm at various dose levels and intervals were studied. Patients had advanced cancer of the head and neck area or pulmonary metastases. The complication rate was related to dose and O_2, and consisted of mandibular osteonecrosis, myelopathy, chondronecrosis epiglottis, severe mucositis and fibrosis, and performation of bowel, increased skin reaction, convulsion, brain radionecrosis, pulmonary fibrosis, and pleural effusion. Cumulative doses ranged up to 6000 R, and were given at various intervals over several weeks. (C.O.)

41498 DOES RADIATION CAUSE FETAL INJURIES. Scherer, E. Landarzt, 43: 328-9(Mar. 10, 1967). (In German).

The question was raised and discussed whether sperm cells irradiated at the time of conception or after could produce injuries of the fetus. The incidences of fetal malformations observed in Hiroshima and Nagasaki after atomic explosions were 1.13 and 0.99%, as compared to 0.77% in nearby unirradiated populations. Since most of the mutations that may have taken place probably were recessive, these have not appeared in the first generations. On the basis of experimental animal studies the irradiation dose required to double the human mutation rate has been estimated to be from 20 to 80 R. In order to avoid injuries to large populations it was indicated that nonmalignant disorders should not be treated with irradiation if the gonads were located in or near the range of the usable beam. It was concluded that because irradiation treatment might cause considerable genetic hazards to populations, it would be advisable to advise male patients to avoid reproduction during irradiation treatment and for a period of four to six weeks afterwards. (BBB)

Radiation Effects on Plants

Refer also to abstracts 41215, 41248, 41272, 41276, 41279, 41280, 41285, 41290–41292, 41294, 41295, and 41512.

41499 CROSS-FERTILITY OF PINE POLLEN, PINUS DENSIFLORA, EXPOSED TO ACUTE γ IRRADIATION. Ohba, Kihachiro (Inst. of Radiation Breeding, Omiya, Japan); Murai, Masafumi. Nippon Ringaku Kaishi, 51: No. 4, 79-84(Apr. 1969). (In Japanese).

The pine pollen, *Pinus densiflora* (Japanese red pine), acutely irradiated with 0, 3.9×10^3, 7.8×10^3, and 11.7×10^3 R of gamma rays from a cobalt-60 source was pollinated to non-irradiated female strobili at the Tohoku Forest Tree Improvement Station (Morioka) and the Institute of Radiation Breeding (Ohmiya, Ibaraki) in 1966. The pollen was collected from a few pine plants of Tozanmatu, a local variety, which were planted in a control field of the Institute of Radiation Breeding in 1962, and the pollen was irradiated at the gamma field of the same institute in May 1966. Exposure rates per day (20 hours) were 3.9×10^3, 7.8×10^3, and 11.7×10^3 R for the pollen pollinated in the Institute of Radiation Breeding, and 3.9×10^3 R for the pollen used in the Tohoku Forest Tree Improvement Station, respectively. At the institute, as female, six-year-old plants of open pollinated progeny of a plus tree, Miyoshi No. 4, were used. At the Tohoku Forest Tree Improvement Station, grafted pines, about ten years old, of seven plus trees were used as female. Mature cones were collected in the fall of 1967. There was observed no apparent correlation between the cone maturity and exposure of the pollen as shown in Tables 1 and 3. Percentage of full seeds was 90.1% and 95.3% in the control and in open pollination. On the other hand, it decreased to 48.5% and 11.1% by gamma ray exposures of 3.9×10^3 and 7.8×10^3 R. One thousand-seed-weight was not affected by the exposure. The number of full seeds per cone seems to be reduced to zero at the exposure of about $8 \times 10^3 \sim 9 \times 10^3$ R in the crosses in both places. Fifty per cent reduction dose for number of full seeds per cone was estimated to be 5×10^3 R. Total seed number per cone was slightly reduced in the exposure range of zero and 7.8×10^3 R, and, at 11.7×10^3 R, even number of empty seeds was reduced. Germination percentage of the full seeds was very high in all exposure plots showing mean values of 97.5%, 99.2%, 93.3%, and 93.3% for respective exposures of the pollen in the crosses at the Institute of Radiation Breeding. For the crosses at the Tohoku Forest Tree Improvement Station, mean germination percentages of the full seeds were 97.1% and 97.5% for the control and 3.9×10^3 R plot, respectively. Frequency of chromosomal aberration (bridge) in root tips was in the range of zero ~ 0.9% in the control and irradiated plots showing insignificant increase of the aberrations. (NSA of Japan)

41500 ULTRAVIOLET LIGHT INACTIVATION AND PHOTOREACTIVATION OF BLASTOCLADIELLA EMERSONII. Coohill, Thomas P.; Deering, R. A. (Pennsylvania State Univ., University Park). Radiat. Res., 39: 374-85(Aug. 1969).

Some effects of ultraviolet light on *Blastocladiella emersonii* have been investigated. An action spectrum obtained at the zoospore stage of development suggests a large nucleic acid involvement in lethality. Zoospores damaged by short-wavelength uv light could be photoreactivated. This result strongly suggests that the critical lesions are pyrimidine dimers, most likely in DNA. Studies of the previously observed cyclical variations in uv sensitivity were extended. Germlings at one of the more resistant stages of the life cycle (1.5 hours of development) did not photoreactivate as rapidly nor to the same extent as did the cells at the very sensitive zoospore stage. These results may indicate a differential repair process or a difference in photoproducts at these stages. Acriflavin and dose fractionation experiments were inconclusive in verifying the existence of repair. Caffeine produced a small differential effect in lowering uv survival at different stages of the life cycle, but cells grown in the presence of this chemical still exhibited a cyclical variation in sensitivity to uv light. (auth)

41501 EFFECT OF GAMMA RADIATION ON SOME PERENNIAL ORNAMENTALS. Banerjee, S. K. (Indian Agricultural Research Inst., Delhi). Indian J. Genet. Plant Breed., 27: 417-22(Nov. 1967).

Mutations were induced in 2 summer perennial ornamentals which are mainly propagated by vegetative means. Cuttings from young vegetative branches of Portulaca grandiflora with showy, double, purple flowers were given ^{60}Co γ-ray treatments at 0, 1, 2.5, 5, 7.5, 10, 25, 50, and 100 kR. Bulbs of Zephyranthes sulphurea, a plant producing yellow flowers in many flashes, were treated with γ radiation at 0, 1, 2, and 5 kR. In Portulaca a strikingly progressive effect of radiation could be seen with the increase in the dose. Cuttings treated with 100, 50, and 25 kR turned yellow after transplantation and gradually dried up after 2, 3, and 7 days respectively. There was no root formation, with consequent cessation of growth and development. Morphological changes occurred in the populations treated with 5 and 7.5 kR, where the leaves appeared to be swollen and had increased chlorophyll after 20 days. The leaf area in these plants was greater than in controls. Flowering was initiated 7 days after transplanting in the controls and was delayed by 6 days in 1-kR and by 11 days in 2.5-kR treated populations. Flower buds could not be found in plants treated with >2.5 kR. Nine flower-mutants in 1-kR and 5 in 2.5-kR groups could be isolated. The mutants were predominantly of 2 types: flowers without any stamens or carpels, and flowers with both. In the controls, the flowers had stamens but usually no stigma, style, or ovary. In Zephyranthes, with increase in treatment dose, there was a decrease in the percentage of flowering bulbs. Initiation of flowering was not changed significantly. There were no morphologic changes in either vegetative parts or in flowers, except pedicel length was affected. The 5-kR treatment drastically reduced plant length to 11.9 cm compared to 26.6 cm in the controls. No change in color and size of the flower could be observed. Sterility was noted in treated populations. Retardation in ovary growth was directly proportional to the dose; after 5 kR no seed could be harvested. Seeds in 1- and 2-kR groups were shrivelled. (BBB)

41502 DESTRUCTIVE EFFECT OF VAPOUR HEATING AND γ RADIATION ON THE GERMINATION OF PAPAVER SOMNIFERUM L. AND CANNABIS SATIVA L. 3. Fujita, Sanaenosuke; Kawatani, Toyohiko (National Inst. of Hygenic Sciences, Tokyo). Hokoku, No. 86, 74-7(Dec. 1968). (In Japanese).

With a view to studying the influence of γ-ray radiation on the mean necessary time (days) for germination of Papaver somniferum L. and Cannabis sativa L., especially whether or not the period after treatment up to the sowing has an accelerative effect on the increase of the mean necessary time for germination, 7 germination experiments ($G_1 \sim G_7$), from the 1st sowing (just after treatment) to the 7th (109 days after treatment), at intervals of about 20 days, were made. Results indicated that the effects of radiation were significant. (NSA of Japan)

41503 EFFECT OF GAMMA IRRADIATION ON POTATOES. Boffi, C.; Ferrari, L.; Ferrara, G. (Univ., Milan). Chim. Ind. (Milan), 51: 173-5(Feb. 1969). (In Italian).

Values for the content of mono-, di-, and trisaccharides, amino acids, and vitamin C in potatoes subjected to γ radiation as a function of absorbed dose and in comparison with nonirradiated potatoes are given. The content of glucose, fructose, and galactose seems to reach a maximum of 230, 230, and 120 mg/100 g after 10 krad and then decreases at 30 krad; sucrose rises to 220 mg/100 g after 5 krad, decreases to 50 at 10 kRad, then rises to 230 at 30 kRad. Amino acid content generally rises with increasing dose. Ascorbic acid content remained constant at low doses and dropped 5% at doses above 7.5 krad. (TSS) (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 40728, 41245, 41283, 41286, and 41521.

41504 EXTRACHROMOSOMAL INHERITANCE IN BACTERIA. Novick, Richard P. (Public Health Research Inst. of the City of New York, Inc., N. Y.). Bacteriol. Rev., 33: 210-63(June 1969).

Because techniques are now readily available for the isolation of small circular DNA molecules, any of the more circumstantial kinds of evidence for plasmid-linked inheritance can be greatly strengthened by the demonstration of a correlation between the phenotype in question and the presence of a specific DNA molecule. These criteria were established on the basis of the known properties of a number of clearly defined, well differentiated extrachromosomal elements that seem to fit into a definite taxonomic category. There may well be other extrachromosomal elements that do not show clearly all of these properties. The detection, identification, and characterization of such less well-defined elements, including any not composed of duplex DNA, may require a rather different approach. (auth)

41505 DISSOCIATION OF MULTIPLE POLYOMA VIRUS FUNCTIONS BY ULTRAVIOLET IRRADIATION. Herberman, Ronald B.; Ting, R. C. (National Cancer Inst., Bethesda, Md.). Proc. Soc. Exp Biol. Med., 131: 461-4(June 1969).

Ultraviolet irradiation of polyoma virus produced differential inactivation of individual viral functions. Infectivity, oncogenicity, and ability to induce HI antibody declined in parallel. The ability of polyoma virus to affect tumor-specific transplantation resistance persisted at a dose of ultraviolet irradiation that resulted in loss of the other viral functions. (auth)

41506 DEVELOPMENT OF RADIATION RESISTANCE IN SALMONELLA CULTURES. Licciardello, J. J.; Nickerson, J. T. R.; Goldblith, S. A.; Shannon, C. A.; Bishop, W. W. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3325. Appl. Microbiol., 18: 24-30(July 1969).

Cultures of Salmonella subjected to repeated cycles of γ irradiation and subculture developed radiation resistance sooner at a low cycling dose (about 1% survival) compared to a high cycling dose (about 0.001% survival). Radioresistant cells in a population of radiosensitive cells of Salmonella newport or S. typhimurium could be selected by the double-irradiation plate method. The frequency of radioresistant cells in a population of S. newport was found to be about 1 per 8.9 million. Radio-resistant cells obtained by cyclic irradiation and subculture were larger (plumper) than the parent strain and showed a marked pleomorphism. (auth)

41507 RESISTANCE OF SPORES OF CLOSTRIDIUM BOTULINUM 33A TO COMBINATIONS OF ULTRAVIOLET AND GAMMA RAYS. Durban, E.; Grecz, N. (Illinois Inst. of Tech., Chicago). Appl. Microbiol., 18: 44-50(July 1969).

Spores of Clostridium botulinum 33A exhibit a sigmoidal survival curve if subjected to γ radiation. The present investigation was concerned with two questions: what is the form of an ultraviolet-survival curve and what is the combined effect of uv- and γ radiation? The uv-survival curve was found to be of sigmoidal type with a shoulder width of 675 ergs/mm^2 and a D_{10} (exp) of 2,950 ergs/mm^2. To test the combination effect, spores were subjected to uv doses of 225, 450, 675, and 900 ergs/mm^2 followed by a series of increasing doses of γ rays from 200 to 2,000 krad in 200-krad steps. The γ ray-survival curves showed that increasing uv pretreatment caused a gradual loss of the shoulder yielding straight line exponential survival curves after preirradiation with uv doses of 675 ergs/mm^2 and above. Simultaneously the D_{10} value for γ irradiation was reduced, e.g., uv preirradiation with 900 ergs/mm^2 reduced the D_{10} by 40%. This observation emphasizes the potential practical advantage of combining uv and γ rays for sterilization of heat-sensitive commodities. (auth)

41508 THERMAL REVERSAL OF ULTRAVIOLET-IRRADIATION DAMAGE IN SALMONELLA TYPHIMURIUM. Gough, Michael (Univ. of Michigan Medical School, Ann Arbor. Baylor Coll. of Medicine, Houston, Tex.). J. Bacteriol., 99: 350-2(July 1969).

The effects of uv irradiation on lysogenic and nonlysogenic Salmonella typhimurium grown at 25 C were partially reversed by shifting cultures to 43 C immediately after irradiation. (auth)

41509 GAMMA IRRADIATION OF FERMENTATION MASHES CONSISTING MAINLY OF CANE MOLASSES. Iizuka, Hiroshi (Tokyo Univ.); Shibabe, Sadami. Agr. Biol. Chem. (Tokyo), 33: 586-91(Apr. 1969).

The application of the radiopasteurization method to fermentation media consisting mainly of molasses was investigated. Gamma irradiation was found to have an excellent pasteurization effect on the fermentation media and at the same time to bring about an increase in the fermentation rate and yield of ethanol. Percent survivals in molasses decreased to ca. 70% by heating at 80°C for 30 min, to ca. 10% by irradiation with 3.0×10^5 rad and to ca. 1% by 6.0×10^5 rad. Irradiated mash was suitable for the medium of the starter, since the rate and the degree of the growth of Saccharomyces cerevisiae in irradiated mash did not differ from those of the growth in heat-pasteurized mash. In the case of the molasses mash supplemented with nitrogen sources, the fermentation rate and yield of ethanol in irradiated mash were larger than those in heated mash. Besides, in the absence of nitrogen sources a 14% difference in fermentation yield was seen between the mash irradiated with 3.0×10^5 rad and the mash heated at 80°C. With the doses ranging from 1.0×10^5 to 9.5×10^5 rad, concentrations of total sugar and direct reducing sugar, pH, and optical density of molasses were little affected by irradiation. (NSA of Japan)

41510 HETEROKARYON FORMATION OF SIMIAN VIRUS 40-TRANSFORMED CELLS IN THE PRESENCE OF ULTRAVIOLET-IRRADIATED SENDAI VIRUS. Dubbs, D. R.; Kit, Saul (Baylor Univ., Houston, Tex.). J. Virol., 3: 536-8(May 1969).

The activation of Simian virus SV40 synthesis is facilitated by treating mixtures of transformed and susceptible green monkey kidney cells with uv-irradiated Sendai virus (UV-Sendai), which causes cell fusion and heterokaryon formation. Over 50 lines of mouse kidney and 3T3 cells transformed by SV40 readily yielded SV40 when co-cultivated with green monkey kidney cells, either with or without prior treatment with UV-Sendai. In contrast, of 83 mouse kidney lines (mKS-U) transformed by uv-irradiated SV40, five lines yielded SV40 only rarely and 48 lines never yielded virus by any technique thus far used, including treatment of cell mixtures with UV-Sendai. Two of the nonyielders, mKS-U2 and mKS-U20, fused poorly with CV-1 cells. The capacity of mKS-U2 to form heterokaryons with CV-1 cells was compared with mKS-U13. Six to 10% of the mKS-U2 nuclei were found in heterokaryons as compared with 65 to 71% of mKS-U13, a good yielder. Moreover, heterokaryons with mKS-U2 rarely contained more than one CV-1 nucleus, but frequently contained five to 10 mKS-U2 nuclei. Thus, failure to rescue SV40 from mKS-U2 may be substantially due to lack of sufficient permissive protoplasm to permit viral replication. Failure to fuse with CV-1 cells is not the explanation for failure to rescue SV40 from many nonyielder lines such as mKS-U5, mKS-U9, mKS-U22, and mKS-U25, in which over 50% of the cells form heterokaryons with CV-1 cells. (BBB)

41511 IRRADIATION OF BACTERIOPHAGES WITH FAST PROTONS. Candoni, B.; Corno, C. (Univ., Milan). G. Microbiol., 15: 197-204(1967).

Results reported were obtained by irradiation, in the dry state with protons of 27.3 MeV, of 5 bacteriophages that differ in the nature and organization of their nucleic acid: Tl, ϕx174, S13, Ec9, and μ2. The last 2 phages are both specific for F^+ and Hfr cells of Escherichia coli K12. The results confirmed the hypothesis of the critical target being the radiation-sensitive DNA responsible for phage reproduction. The critical target seemed to have the same dimensions (1.7×10^{-18} cm^3) for all DNA phages irradiated. On the other hand, the existence of a dual inactivation mechanism explained both the different behavior of wet inactivated bacteriophages and the dependence of the ratio $D_{37\phi x174}/D_{37T1}$ on the LET for highly ionizing particles. The sensitive volume (critical target) of the RNA phage μ_2 is smaller than the critical volume of DNA phages and is practically equal to the whole content of nucleic acid of the phage. For the RNA phage μ_2 the cross section and the mean thickness were in good agreement with a sensitive volume of 1×10^{-18} cm^3 which equals the whole volume of the phage's nucleic acid. (BBB)

41512 CELLULAR REPAIR PROCESSES: SURVIVAL OF IRRADIATED YEAST, BACTERIA, AND PHAGES UNDER DIFFERENT POSTRADIATION CONDITIONS. Korogodin, V. I.; Kapultcevich, Yu. G.; Myasnik, M. N.; Mosin, A. F.; Gridnev, V. V. (Inst. of Medical Radiology, Obninsk, USSR). Advan. Biol. Med. Phys., 12: 253-74(1968).

From the cited data, the complexity and variety of manifestation of recovery effect as well as the fascination of this problem in a general biological sense are clearly indicated. Despite a great deal of work, a thorough investigation of this problem has in fact only begun. It is not yet known how various forms of recovery are connected with each other and whether they are based on one and the same or on different mechanisms. It is not known why the recovery process is closely connected with the ploidy of yeast cells, why haploid yeast is incapable of recovery while the corresponding homozygous ones successfully recover from uv, x γ, α, and other radiations. It is not known what biochemical processes guarantee recovery of various organisms from different kinds of lesions, if there are special recovery systems, or if recovery processes are due to the same enzymes that guarantee the synthesis of corresponding elementary intracellular structures in a normal cell ontogenesis. It is not known what the role of reparation processes is on the cell level in nonirradiated organisms. Assumptions can only be made on all these points. Now, however, more and more new investigators and scientific groups have become engaged in investigations of recovery, and it is hoped that time is near when all these questions will be answered. (C.O.)

41513 THYMINELESS DEATH IN ESCHERICHIA COLI: INACTIVATION AND RECOVERY. Cummings, Donald J.; Kusy, Alvin R. (Univ. of Colorado, Denver). J. Bacteriol., 99: 558-66(Aug. 1969).

The effects of chloramphenicol (CAP) on the progress of thymineless death (TLD), nalidixic acid (NA) inactivation, uv irradiation, and mitomycin C (MC) inactivation were studied in Escherichia coli B, B_{s-1}, B_{s-3}, B_{s-12}, and B/r. This was done before, during, and after inactivation. During the progress of inactivation, it was found that at 10 to 20 μg of CAP per ml, up to 50% of the uv-radiosensitive bacteria survived TLD and about 10% survived NA. In E. coli B/r, at these concentrations of CAP, about 10 to 15% of the cells survived TLD and about 20 to 25% survived NA. Concentrations of CAP greater than 25 μg/ml actually increased the sensitivity of E. coli B, B_{s-1}, B_{s-3}, and B_{s-12} to inactivation by either TLD or NA; at 150 μg of CAP per ml, the sensitivity of E. coli B/r to inactivation also increased. When E. coli B cells were incubated in CAP prior to inactivation, the longer the preincubation the longer onset of TLD was delayed; NA inactivation was also affected in that the rate of inactivation after CAP incubation was greatly decreased. Preincubation of E. coli B/r with CAP had much less effect on the progress of inactivation. After thymineless death, incubation in CAP plus thymine led to a rapid and almost complete recovery of E. coli B and B_{s-12}. Lesser recoveries were observed after inactivation due to uv, NA, or MC inactivation. E. coli B_{s-1} and B/r did not recover viability after any mode of inactivation, and E. coli B_{s-3} and B_{s-12} recovered from uv to about 20% of the initial titer. It was suggested that protein synthesis, in particular proteins involved in DNA synthesis, was a determining factor in these inactivating and recovery events. (auth)

41514 CHROMOSOMAL ABERRATIONS AND CLONING EFFICIENCY IN ADENOVIRUS TYPE 12-INFECTED HAMSTER CELLS. zur Hausen, Harald (Children's Hospital of Philadelphia. (Univ. of Pennsylvania, Philadelphia). J. Virol., 2: 915-17(Sept. 1968).

The fate of hamster cells, abortively infected with adenovirus type 12, was studied by correlation of chromosomal aberrations with induction of T antigens and cloning efficiency. The incidence of chromosomal changes paralleled to some extent the T antigen formation, but was inversely related to the cloning efficiency of the cells. At an input multiplicity of 100, within 24 hr after infection, nearly all of the cells or metaphases revealed the presence of T antigens and chromosomal lesions, respectively, but no clones of cells were obtained. Inhibition of cellular DNA synthesis was not noted during this period. Increasing doses of ultraviolet irradiation reduced, successively, the capacity of the virus to induce chromosomal aberrations and correspondingly improved cloning efficiency of the exposed cells. It is concluded that most, if not all, cells revealing chromosomal lesions 24 hr after infection fail to enter further mitoses. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 41503.

41515 (ORNL-tr-2160) RADIATION PRESERVATION OF FOOD. VI. PRELIMINARY INVESTIGATIONS ON STRAWBERRIES. Garcia de Mateos Lopez, A.; Rivas Garcia, A.; Ortin Sune, N.; del Val Cob, M. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Symposium on Applications of Radioisotopes, Madrid, June 19-21, 1967. 15p. (CONF-670649-46). Dep. CFSTI.

Fresh strawberries were placed in glass containers, refrigerated with ice, and irradiated at a dose rate of 920 krads/hr. Following irradiation, tests made on the fruit showed that irradiation prolongs the storage time for strawberries treated with 200 to 250 krads by three to four days while the controls are acceptable for about a day. From the standpoint of microbial attack, irradiated strawberries are commercially acceptable for 15 to 20 days after treatment while controls last only about eight days. Changes in ascorbic acid content as a result of irradiation are not nutritionally significant and under some conditions the value is higher than the initial value. Refrigeration is basic as a supplement to irradiation for increasing storage time. Development of Botrytis cinerea and other fungi is inhibited by radiation and by refrigeration. (H.L.W.)

41516 (ORNL-tr-2191) USE OF ^{137}Cs GAMMA RADIATION IN TESTS ON FOOD PRESERVATION. Fernandez y Gonzalez, A. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from report CONF-670649-21. 19p. Dep. CFSTI.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

Results are reported from experiments on irradiation of foods, using a ^{137}Cs γ source. Positive results obtained on inhibition of sprouting in potato tubers are reported, as well as the absence of any effect of 5 and 500 ppm of giberellic acid in causing recovery of the sprouting capability of irradiated potatoes. The effect of irradiation in killing three Coleoptera species, which infest cereals and their derivatives, is reported for Sitophilus granarium, Trogoderma granarium, and Tribolium castaneum. Data obtained on the nutritional value of the proteins in a mixture of wheat flours, irradiated to levels of 20 and 200 rads, do not indicate any significant differences between the irradiated and nonirradiated products. Irradiation of strawberries, Fragaria chiloensis, increased their commercial preservation time. Doses of some 200 krads allowed good preservation for five to six days at ambient temperature, which could be prolonged to 18 to 20 days if the temperature was kept at no higher than 4°C. The effect of γ radiation on the survival of yeasts present in grape and apple wines was investigated, with the objective of radiation processing these products. Some results on the change in the fermentation chronology are presented as a function of dose, and the various species of yeasts isolated from juices previously irradiated with 1 Mrad are noted. (C.H.)

41517 (TID-24317) APPLICATION OF RADIATION-PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER. Annual Report, November 1, 1966–October 31, 1967. Miyauchi, David; Spinelli, John; Pelroy, Gretchen; Teeny, Fuad; Seman, John (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.). Nov. 1967. Contract AT(49-11)-2058. 136p. Dep. CFSTI.

Separate abstracts were prepared for each of the six sections of this report for inclusion in NSA. (C.O.)

For abstracts of individual sections see: 41518–41523.

41518 (TID-24317, pp 9-34) RADIATION-PASTEURIZATION OF FISHERY PRODUCTS IN LARGER UNITS FOR INITIAL STORAGE AND DETERMINATION OF THE STORAGE-LIFE CHARACTERISTICS OF THE PRODUCTS DURING SUBSEQUENT HANDLING FOR RETAIL OR INSTITUTIONAL USE. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

Experiments were conducted on cod fillets, Dungeness crab, ocean perch, and oysters, all from the Pacific, to extend their shelf life through irradiation. Cod fillets that were vacuum packed in heal-sealable polyester pouches and irradiated at 0.1 and 0.2 megarad doses had two to three times greater shelf life that nonirradiated controls. Oysters, either vacuum packed in cans or air packed in glass jars, that were irradiated at a dose of 0.2 megarad had an extension of shelf life by 10 days over controls. Dose of 0.1 megarad to the oysters was as effective, but only when stored at low (33°F) temperatures. Whole cooked Dungeness crab irradiated in the shell at 0.2 megarad increased the shelf life by four days. Eviscerating the cooked crab before irradiation increased the storage life by another 10 days. Experiments were also conducted on the feasibility of irradiating fillets in large wholesale packages for repacking later into retail packages. It was found that oxygen-impermeable packaging of ocean perch and sole fillets gave the best results. Of the packaging materials readily available to fish processors, it was found that the No. 10 size C-enameled can was the most suitable. Fillet tins lined with polyethylene bags were satisfactory providing careful handling to eliminate air packets was assured. Polyethylene bags alone were not satisfactory for more than a week. Results of fillets irradiated in wholesale packages at 0.2 megarad and stored for 7 to 14 days at 33° followed by repacking into smaller retail units showed an additional storage life equivalent to the normal storage life of the nonirradiated control fillets. It was concluded that radiation processing of fish fillets in wholesale units would permit the fillets to maintain good condition with sufficient shelf life for the retail market. (C.O.)

41519 (TID-24317, pp 35-58) SHIPPING AND ACCEPTABILITY STUDIES ON IRRADIATED FISHERY PRODUCTS. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

Tests were made of the effects of shipping conditions on the quality of irradiated seafood. The most suitable packaging materials were either the fillet tins or paperboard cartons with oxygen-impermeable plastic bag liners. Temperature data indicated that good handling practices were followed by the distributors and that fish were not exposed to temperatures permitting outgrowth of pathogenic organisms. Good quality fillets irradiated at 0.1 megarad have a shelf life of at least 14 days in iced storage. Doses of 0.2 megarad had somewhat lower bacterial counts. In a shipment from Boston, Massachusetts, to Seattle, Washington, that included both irradiated and control fillets, the nonirradiated fillets were of unmarketable quality, but the irradiated fillets had an additional storage life after shipment of one to two weeks. (C.O.)

41520 (TID-24317, pp 59-83) EFFECT OF STORAGE TEMPERATURES ON SHELF LIFE AND SPOILAGE CHARACTERISTICS OF IRRADIATED AND NONIRRADIATED FISH. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

The effect of various elevated storage temperatures on the composition of the microflora of irradiated and nonirradiated vacuum-packed petrale sole fillets was determined. Petrale sole fillets that were vacuum packaged in mylar-polyethylene bags were irradiated at 0, 0.1, 0.2, and 0.3 megarad and stored at 33°, 38°, 42°, 50°, 60°, and 72°F. Generic changes in the aerobic flora were determined by the identification of nearly 14,000 microbial isolates. The predominant spoilage flora at the time of spoilage of the nonirradiated fish stored at 42°F and below were Pseudomonas and of the nonirradiated fish stored above 42°F were lactobacilli. In comparison, the predominant spoilage flora of the irradiated fish stored at all temperatures were lactobacilli. Coliforms and enterococcus showed outgrowth at the higher storage temperatures but were suppressed by the radiation treatment. Coagulase-positive Staphylococcus were found in some of the nonirradiated samples but were not found in any of the irradiated samples. The maximum shelf life or X-value (the time required to obtain unanimous rejection of samples by a consumer-type panel on the basis of odor of raw fillets) was determined for nonirradiated and irradiated (0.05, 0.1, and 0.2 megarad) petrale sole, Pacific cod, and haddock that were stored at various temperatures between 35° and 60°F. These X-values are compared with the minimum time for toxin development in corresponding samples inoculated with Clostridium botulinum type E spores. (auth)

41521 (TID-24317, pp 84-103) MICROBIOLOGICAL ASPECTS OF THE SAFETY AND FEASIBILITY OF VACUUM PACKAGING VERSUS AIR PACKAGING OF IRRADIATED FISH. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

Since some species of Lactobacillus inhibit the growth of Staphylococcus aureus and Clostridium botulinum, experiments were undertaken to determine the numbers and characteristics of low-temperature lactobacilli occurring on vacuum-packed, irradiated oysters and petrale sole fillets and to determine the effect of lactobacilli on the growth of S. aureus and C. botulinum in mixed culture. Microflora isolated from the oysters at time of spoilage were all lactobacilli as were the majority from the sole fillets, but the latter had varied characteristics. Studies of 2,568 isolates gave the following results: Some degree of inhibition of S. aureus was shown in 57% of the isolates. The number of inhibitory organisms found increased as the radiation dose increased. The temperature of storage did not affect the percentage of inhibitory organisms found. Cultures that produced large amounts of lactic acid were not always inhibitory and vice versa. It was concluded that these preliminary experiments showed that some of the lactobacilli from irradiated fish are capable of inhibiting the outgrowth of the Beluga strain of C. botulinum Type E. The ability of the lactobacilli to inhibit C. botulinum did not appear to correlate with their ability to inhibit S. aureus or to produce acid. (C.O.)

41522 (TID-24317, pp 104-15) STORAGE LIFE AND QUALITY CONTROL. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

A comparative storage-life study was made on fillets that were machine-cut and hand-cut. The longer storage life of the machine-cut fillets was related to their lower bacterial counts both before and after irradiation. Measurements were made on the alteration of tissue constituents that occurred in irradiated fillets during storage. The amount of myofibrillar protein that could be extracted with 5% salt (NaCl) showed some relation to the texture alteration. Depending on the species, however, salt-extractable protein did not always correlate with toughening. In English sole, for example, a decrease in salt-extractable protein was accompanied by a softening of the tissue. The free glucose content in fish tissue was found to gradually decrease in irradiated fillets during storage. Glucose values of 0.02 mg/g always correlated with spoilage. Free ribose, however, did not decrease during storage. The first apparent changes in free ribose content were evident only when apparent spoilage was detected in the fillet. (auth)

41523 (TID-24317, pp 116-135) PRETREATMENT OF FISH WITH ADDITIVES. (Bureau of Commercial Fisheries, Seattle, Wash. Technological Lab.).

Fish fillets treated with solutions of condensed phosphates, such as sodium tripolyphosphate (TPP), prior to irradiation are superior to untreated fillets with regard to certain storage characteristics. The treated fillets show practically no drip loss, maintain better texture characteristics, and are less labile to color alteration during storage. It was demonstrated that solutions of TPP could be effectively applied by spraying the fillets instead of dipping them. A laboratory model of a spray machine was built to demonstrate the feasibility of continuously spraying fillets. Comparative tests on dipped fillets and fillets put through the spray unit showed that the fillets had the same storage characteristics regardless of the method of application. Studies on the mode of action between TPP and fish tissue protein support the contention that TPP essentially reacts with the surface protein, and that the retained water-holding capacity of the treated fillets is due to a surface barrier of modified protein. Other studies showed that TPP is not hydrolyzed to pyrophosphate (PP) during storage, thus showing that TPP need not be converted to PP to exert an effect on tissue protein. It was also found that TPP does not alter the rate of nucleotide degradation in fish tissue. (auth)

41524 (TID-25154) PLANETARY QUARANTINE PROGRAM. Thirteenth Quarterly Report of Progress for Period Ending June 30, 1969. (Sandia Labs., Albuquerque, N. Mex.). June 1969. 42p. Dep. CFSTI.

Studies concerning sterilization models, qualitative sampling models, bioburden experimentation and models, and evaluation of release from surfaces of the spacecraft-lunar module adaptor (SLA) during launch are described. Along with these other phases of planetary quarantine problems, a study of the feasibility of combined irradiation and heat sterilization of spacecraft hardware is reported. Heat alone has presented difficulties since some instruments are vulnerable at high temperatures. Dry spores of Bacillus subtilis var. niger, temperature ranges of 100 to 125°C, and low doses of γ radiation (under 150 krads) were used. Results indicated that a reduction of the initial population by 90% could be accomplished in roughly 30 to 50% of the time when heat and radiation were combined. Experiments with other organisms have also begun. (C.O.)

41525 EFFECT OF IIRRADIATION ON POTATOES AND VEGETABLES. Stone, G.; Menzies, J. A.; Campbell, J. D. (Manitoba Dept. of Agriculture, Winnipeg). Proc. Annu. Conf. Manitoba Agron., 56-9(Dec. 1966).

The effect of γ radiation of potatoes, using 8.5 krad, on reducing sugars, ascorbic acid, darkening after cooking, dry matter content, color and oil content of chips was studied. Although irradiation had a significant effect on a number of factors under study, the differences between the irradiated and non-irradiated potatoes were not great enough to be of practical importance in most cases. The exception was after-cooking darkening where some samples were considered unacceptable. Effects on turnips, onions, carrots, celery, sugar beets and mushrooms were also examined. (Canada)

41526 IRRADIATION OF FISH. Meyer-Waarden, P. F. Fette-Seifen-Anstrichm., 70: 984-7(Dec. 1968). (In German).

Procedures and equipment used in the German fishing industry for irradiation preservation of fish were described and discussed. The lack of effect of irradiation even at energies as high as 10 MeV on induction of radioactivity, decrease in caloric value, or reduction in protein quality was emphasized, but the loss of vitamins was also recognized as a detrimental factor. Studies demonstrated no evidence of toxicity or carcinogenicity in irradiated fish. Refrigerated fish may develop offensive odors after irradiation. In fish irradiated with a 175,000-Ci ^{137}Cs source after 3 days refrigeration, the microorganism counts/g were 656,000, 53,000, 20,000, and 18,000 in controls and fish irradiated with doses of 100, 200, and 250 kR, respectively, and refrigerated for 3 days after irradiation. However, some odor and taste changes were caused by these irradiation doses. The effects of fractionated irradiation with two 50-KR doses were equivalent to a single 300-KR dose. Equipment for onboard irradiation of fish with ^{60}Co, with a capacity of 5000 KR/Kg/hr, a ^{137}Cs irradiator with a 30,000-Ci source, and x irradiation equipment were described. Recent progress in legal aspects of irradiation preservation in the fishing industry were outlined. (BBB)

41527 EFFECTS OF THE ^{137}Cs ON THE STERILITIES OF CALLOSOBRUCHUS CHINENSIS L. STUDIES ON THE ECOLOGY OF INSECT WHICH WAS STERILIZED ARTIFICIALLY (GAMMA RADIATION). 2. Kiyoku, Masao; Tsukuda, Ritsuko (Okayama Univ., Japan). Okayama Daigaku Nogabuku Gakujutsu Hokoku, No. 32, 15-23(Oct. 1968). (In Japanese).

In the first experiment untreated females mated with males exposed to 8000 R in the pupal stage produced fewer eggs than the control and none of the eggs hatched. Females, irradiated at 6000 R in the pupal stage and mated with unirradiated males, also deposited non-viable eggs. Adults surviving irradiation were almost normal in appearance and behavior as compared with controls. It is suggested that doses of ^{137}Cs required to complete sterilization of Callosobruchus chinensis are above 6000 R for females and above 8000 R for males. However, the percentages of emergence from male pupae exposed to 8000 R and the female pupae exposed to 6000 R were approximately 40 and 50%, respectively. Adults of both sexes were shorterlived than adults from untreated pupae. Virgin females were mated first with males irradiated at 6000 R and three days later with unirradiated males. These females produced non-viable eggs until the subsequent mating with unirradiated males after which they produced fewer viable eggs than the control. When virgin females were mated first with untreated males and three days later with treated males, they produced as many viable eggs as the control. When male and female weevils were confined in a ratio of 6 irradiated males : 1 unirradiated male : 1 unirradiated female, a 50% reduction in the F_1 generation occurred. When the weevils were confined in a ratio of 8 irradiated females : 1 unirradiated male : 1 unirradiated female, the reduction in the F_1 generation was somewhat lower. (NSA of Japan)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 40887 and 40913.

41528 (BNL-50149, pp 89-122) METALLURGY AND MATERIALS SCIENCE DIVISION. Gurinsky, D. H. (Brookhaven National Lab., Upton, N. Y.).

Activities in the materials testing program devoted to evaluation of corrosion and mass transfer by liquid Na of potential containment and fuel cladding materials for use at 760 to 815°C are reviewed. The current status of the program is presented tabularly. Research on physical chemistry aspects of Na reactions with Ni and Fe is summarized along with results of investigations of Na impurity chemistry, Na-O chemistry, Na-H reactions, and Na-C reactions. Efforts devoted to development of methods for studying impurities reactions with sodium by electrochemistry are reported along with results of work on Na analytical methods. Work on radiation effects on LMFBR fuel cladding and plastic deformation of bcc metals is summarized along with work on superconductivity, properties of liquid metals, and metallographic techniques. (J.R.D.)

41529 (BNL-50179) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review, Volume 7, Number 2, April 1969. (Brookhaven National Lab., Upton, N. Y.). 41p. Dep. CFSTI.

Reviews are presented of information on fluid dynamics, heat transfer, materials development, instrumentation, component development, systems studies, chemistry and chemical analysis, fabrication techniques, safety, and component design. (J.R.D.)

41530 (ORNL-tr-2170) CONCENTRATION CHANGES IN BINARY METAL-GAS SOLUTIONS IN THE CASE OF SIMULTANEOUS EVAPORATION OF GAS AND METAL. [PART I]. Hoerz, Gerhard. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Metallk., 60: 115-20(1969). 14p. Dep. CFSTI.

Concentration changes in binary metal-gas solutions during simultaneous removal of gas and evaporation of metal are investigated. Cases discussed in which the gas (G) is removed by the evaporation of the metal-gas compound (MG) and by the desorption of the gas molecule G_2. In both cases the formation and evaporation of MG or G_2 are assumed to be the rate-determining step. Conditions are discussed under which the gas concentration in the metal decreases, is constant, or increases. Relations for the dependence of the gas concentration in the metal-gas solution on the annealing time are reported and discussed for special cases. For negligible gas uptake and a ratio of k_M (rate constant of metal evaporation) to k_C (rate constant of gas removal) which is not too high it was found that if the gas removed obeys a first order rate law the gas concentration in the metal-gas solution decreases continuously with increasing annealing time without reaching a limit value. If the gas removal obeys a second order rate law a limit value x_g of the gas concentration x in the metal exists. For $x > x_g$ x decreases down to x_g during annealing. For $x < x_g$ x increases up to x_g during annealing. Both the concentration limit x_g for a second order degassing process and the final concentration $x = 0$ for a first order degassing process are reached but not until all of the metal is evaporated. (auth)

41531 (UCRL-18735) INORGANIC MATERIALS RESEARCH DIVISION ANNUAL REPORT, 1968. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 248p. Dep. CFSTI.

Separate abstracts were prepared for the four main sections of this report. (L.M.T.)

For abstracts of individual sections see: 40616, 41532, 41692, and 42478.

41532 (UCRL-18735, pp 81-128) METALLURGY. (California Univ., Berkeley. Lawrence Radiation Lab.).

Research progress is reported on plastic deformation in Cu polycrystals, formation of voids and dislocations loops in Al, dislocations in Au, dislocations in Si, high temperature creep, climb associated creep, deformation of Mo steel, model of thermally activated deformation in bcc metals, plastic behavior of Mo, plastic behavior of Mo-Re alloys, strain hardening AgMg, dislocation strengthening of metals, dynamic behavior of Al and Al-Cu alloys, properties of strain aged steels, properties of Fe-Ni-Co-C steels, strengthening Type 304 stainless steel, structure of yttrium-aluminum garnets, anomalous absorption by crystals, Kikuchi diffraction, electron absorption, high voltage electron microscopy, fracture of Trip steels, fracture of composite materials, strain studies on Ti-Al alloys, martensite transformation, precipitation hardening of Al alloys, cracking of Ti alloys, superconductivity of Nb-Zr and Nb composites with Sn and C, superconductivity of Pb-Tl alloys, and Pb-In phase diagram. (J.R.D.)

41533 SURFACES AND INTERFACES. II. PHYSICAL AND MECHANICAL PROPERTIES. Proceedings of the 14th Sagamore Army Materials Research Conference Held at Raquette Lake, New York, August 22-25, 1967. Burke, John J.; Reed, Norman L.; Weiss, Volker (eds.). Sagamore Army Materials Research Conference Proceedings. Syracuse, N. Y., Syracuse University Press, 1968. 505p. $23.00. (CONF-670849).

Information contained in the sixteen conference papers is presented on surface sensitive mechanical properties, environment-sensitive mechanical properties, control of grain structure, and composite materials. (J.R.D.)

41534 FUEL AND FERTILE MATERIALS. Reactor Mater., 12: 155-70(Fall 1969).

Research and development results are reviewed on unalloyed U, alpha phase adjusted U alloys, gamma phase U-base alloys, delta phase U-base alloys, Pu metal and alloys, Pu compounds, Th and Th alloys, Th and U oxides, Pu and U carbides and nitrides, and radiation effects on fuel materials. (J.R.D.)

41535 REACTOR MATERIALS. Volume 12, Number 3. Simons, E. M.; Keller, D. L. (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Institute, Fall 1969. 68p. GPO $0.70.

Research and development progress is reviewed in four sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 41534, 41536, 41537, and 41734.

41536 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 12: 210-19(Fall 1969).

Results of research and development are reviewed on fabrication of cast materials, fabrication by powder metallurgy, plating methods, explosive forming, welding, and nondestructive testing. (J.R.D.)

41537 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 12: 177-209(Fall 1969).

Research and development results are reviewed on corrosion of Zr alloys, Al alloys, steels, Cu alloys, Hf alloys, heat-resisting metals, Co alloys, Ni alloys, graphite, and boron carbides. Cladding reactions in meltdown experiments are reviewed along with results on structural materials irradiation and radiation testing of pressure vessel steels. The mechanical properties of cladding materials are reviewed. Information from diffusion studies is included along with information on the metallurgy of refractory metals. Development of prestressed pressure vessels is discussed. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 40656, 40797, 40799, 41570, 41574, 41600, 41604, 41608, and 41685.

41538 (CEA-N-1044, pp 93-137) CORROSION STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

Studies were made on the corrosion of various alloys by water and water vapor. The alloys included Zircaloy-2, Zr-base alloys, Inconel-600, and various steels and stainless steels. Studies were also made on the corrosive effects of nitric acid on stainless steel and graphite/stainless steel couples. A statistical model for correlating results on corrosion studies is described. (P.C.H.)

41539 (EUR-4195) STUDY OF CAVITATION PHENOMENA. Final Report. Galotto, C. P.; Mannone, G.; Casali, M.; Artusio, G. (FIAT, Turin (Italy). Sezione Energia Nucleare). 1969. Contract 038-65-9-IRAI. 94p. (In French). Dep.

Cavitation phenomena were studied systematically by means of a device which combines the advantages of continuous and discontinuous systems for measuring cavitation damage and employs radioactive tracers to provide high measuring sensitivity. The rig consists basically of a closed loop into which the sample is inserted and then vibrated by an electrodynamic exciter. This device can be used to investigate cavitation as a function of the amplitude and frequency of the excited test-piece, to measure the damage produced by varying the temperature, speed, pressure and dissolved gas content of the cavitating liquid, and to measure the grain-sizes of the eroded particles in a simple manner. Further advantages of the rig are its compactness as compared with hydrodynamic systems, and the drastically shortened test times, made possible by the remarkable accelerations obtainable with electrodynamic excitation and by the high sensitivity of the damage measurements afforded by radioactive tracers. This process was successfully used to distinguish, under normal operating and transient conditions, the erosion strength of various materials in reproducible experimental conditions and to highlight the mechanical and physicochemical parameters that have a determining effect on cavitation. (auth)

41540 (EURFNR-614) THE CORROSION PHENOMENON OF INTERNAL OXIDATION INDUCED BY LIQUID SODIUM WITH A VERY SMALL SODIUM OXIDE CONTENT. Borgstedt, H. U.; Frees, G. (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK-879. 18p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Metal phase embrittlement, caused by oxygen penetration, was observed when titanium-containing vanadium alloys were corroded by liquid sodium with oxide contents below 10 ppM in the 500 to 600°C temperature region. It was shown that the thermodynamic conditions for internal oxidation of vanadium–titanium alloys exist in the flowing sodium under test conditions. Oxygen penetration into the alloys obeys the laws related to the appearance of internal oxidation. Pointers for alloy development can be derived from the results. (auth)

41541 (GEAP-10036) SODIUM COMPONENTS DEVELOPMENT PROGRAM. MASS TRANSFER INVESTIGATIONS IN LIQUID METAL SYSTEMS. Quarterly Progress Report No. 9, March–May 1969. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). June 1969. Contract AT(04-3)-189. 35p. Dep. CFSTI.

Activities in a program to determine corrosion rates in candidate reactor structural materials, the effects of corrosion on mechanical properties, and the effects of corrosion on Na impurities are reported. The studies are being conducted using test loops at 1300°F. Materials being studied include Types 304, 316, and 347 stainless steels and Incaloy 800. Efforts during the report period were devoted to corrosion studies on Type 316 stainless steel in sodium loop run 8-4 at 1300°F and to sodium-impurities interactions. Work is also reported on efforts to determine the mechanical properties limits for cladding materials and localized attack parameters. (J.R.D.)

41542 (MSAR-69-102) EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, January–March 1969. (MSA Research Corp., Evans City, Pa.). June 1969. Contract AT(11-1)-765. 105p. Dep. CFSTI.

Activities at the test facilities for the program are summarized. Preparations are being made at loop 1 for excursions of stainless-steel samples in accord with the plans for determining the synergistic effects of carbon and oxygen environments on sample mechanical properties. The operation of this system for the calibration and evaluation of the UNC carbon meter continues. Adjustments are being made at loop 2 for the sodium-oxygen excursion of stainless-steel samples, in accord with the plans for determining the synergistic effects of environment on sample mechanical properties. Loop 3 is being used for creep-rupture testing specimens previously exposed to the conditions of Loop 1 (high carbon-sodium) and Loop 2 (high oxygen-sodium). Operating conditions are based on 1200°F clean sodium (less than 10 ppM oxygen); sodium velocity of 20 ft/sec across the test specimens; and a system ΔT of greater than 70 up to 150°F. Calibration of the oxygen meters continues. At retort 1, long-term (10,000-hour minimum) exposure of $2\frac{1}{4}$ Cr-1 Mo samples in 1050°F clean sodium (less than 10 ppM oxygen) is continuing. At retorts 2 and 3, screening tests for ferritic alloy steels exposed for 1000, 3000, and 4000 hours in 1200°F clean sodium are completed. Titanium-stabilized 5 Cr-$\frac{1}{2}$ Mo is to be further investigated along with the tantalum/niobium stabilized $2\frac{1}{4}$ Cr-1 Mo (3HK5S) of Thyssen steel and other stabilized ferritic alloy steels as they become available. At retort 4, long-term (10,000-hour minimum) exposure of Type 304 and 316 ss samples in 1200°F clean sodium continues. (auth)

41543 (WAPD-Trans-122) BREAKAWAY MECHANISM DURING THE CORROSION OF ZIRCONIUM. Ullrich, Georg. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from Z. Metallk., 59: 292-6(1968). 13p. Dep. CFSTI.

During the corrosion of zirconium and its alloys in oxygen-containing media at temperatures which induce scale formation, the law of thickness-growth obeys, as a rule, the growth law $x^n = k \cdot t$, as long as the oxide layer has a protective action. If the coating is lost by cracking of the oxide, deviations appear which in the case of zirconium, follow a linear time law, with extensive destruction of the oxide layers. Regarding the temporal progress of the strain $\sigma(t)$ in the oxide, an approach is made which is based on the assumption that the tensile strength in the oxide changes to the extent that the tensile strength in the metal is reduced by relaxation, within the relaxation time τ_1. This temporal progress of the stress may be inserted into the formula of the Boltzmann and may be determined by measuring the weight increases of corroding samples with increasing contents of alloys. A differential equation is presented which satisfies the additional strain Σ_Z. (auth)

41544 IMPROVED SILICIDE COATINGS FOR THE PROTECTION OF MOLYBDENUM–0.5 PERCENT TITANIUM ALLOY. Hayman, C. (Fulmer Research Inst., Ltd., Stoke Poges, Eng.); Restall, J. E. J. Less-Common Metals, 19: 9-21(Sept. 1969).

A method of siliconizing and boriding a molybdenum – 0.5% titanium alloy by reaction with silicon dichloride and boron monofluoride vapors is described. Comparison of the high-temperature oxidation resistance of simple silicide and boron-modified silicide coatings on molybdenum revealed that the addition of boron led to improvement in oxidation resistance, particularly under thermocycling conditions. Boron-modified coatings subjected to a maximum test temperature of 1100°C, however, were appreciably less resistant than those tested at a maximum temperature of 1200°C. The results of impact tests, and of metallographic, electron-probe and x-ray analyses are reported. (auth)

41545 EFFECT OF APPLIED CURRENT ON STRESS CORROSION OF BERYLLIUM. King, T. T. (Airframe Subsystems Engineering, Wright-Patterson AFB, Ohio); Myers, J. R. Corrosion, 25: 349-51(Aug. 1969).

Effect of galvanostatic anodic and cathodic currents on the stress corrosion of beryllium sheet material in aerated, synthetic sea water at 72°F was determined. Applied anodic currents reduced the time-to-failure; cathodic currents prevented pitting and subsequent stress corrosion. Mechanism for premature failure was associated with rapid anodic dissolution along an active path nearly normal to the applied tensile stress. Hydrogen cracking was excluded as a primary factor in the failure mechanism. (auth)

41546 OXIDATION OF RIMMING STEELS IN CARBON DIOXIDE ATMOSPHERES. Goodison, D.; Harris, R. J. (Nuclear Design and Construction Ltd., Whetstone, Eng.). Brit. Corros. J., 4: 146-33(May 1969).

The power-producing nuclear reactors in Britain use carbon dioxide gas as the heat transfer fluid between the reactor core and the boilers. Because of radiation hazards and mechanical design, some components in the gas circuit must operate without maintenance for the reactor life of up to 30 yr. These components are generally of mild steel and consequently there is a need for long-term oxidation data on such steels in simulated reactor environments. The investigation described was concerned with the oxidation resistance of rimming steels at 400°C to CO_2, and the effect of small quantities of CO and H_2O in the gas. It was shown that protective oxide films are usually formed at a gas pressure of 1 atm, but at high pressures and particularly with moisture and CO in the gas, the oxide film may locally break down, giving rise to oxide excrescences which can grow in size and number to cover most or all of the surface of the specimen. The formation of excrescences causes the rate law to change from cubic or parabolic to linear over a transitional period. The reaction rate constants are dependent essentially on the temperature while moisture, CO and gas pressure are mainly effective in promoting the initiation and development of excrescences. Possible causes for the formation of excrescences, as well as the mechanism of the linear rate law during the postbreakaway period, are discussed. (BBB)

41547 OXIDATION OF AUSTENITIC STAINLESS STEEL BOILER TUBING IN CARBON DIOXIDE. Board, J.; Winterborne, R. (Atomic Power Construction Ltd., Hounslow, Eng.). Brit. Corros. J., 4: 86-93(Mar. 1969).

The long-term corrosion characteristics of austenitic stainless steels in a typical advanced gas-cooled reactor (AGR) coolant were determined with emphasis on the effect of fabrication route. Fin-rolled AISI Type 316 and Type 347 stainless steel tubings were studied and the tests were carried out at 650 and 700°C at pressures of 400 and 600 psig in CO_2 containing 1 vol-% CO and

200 ppM water vapor. Weight gains, metallography, and microprobe analysis results indicated that heavily cold-worked material has the best oxidation resistance owing to the formation of a Cr_2O_3 protective scale. Oxidation of material heat-treated in nitrogen at the lower temperatures resulted in the formation of a less resistant spinel type oxide, while the material heat-treated in nitrogen at the higher temperature suffered severe pitting attack. Heat treatment in air at all temperatures provided a fairly resistant oxide film during subsequent oxidation in CO_2. Hence, heat treatment in air is preferable to heat treatment in nitrogen, and leaving the heat-treatment scale on surfaces which are subsequently to be exposed to CO_2-based environment is recommended. Type 316 stainless steel showed better oxidation resistance than Type 347 stainless steel. During boiler fabrication the assembled boiler tubing is given a final solution treatment at about 1050°C. The results indicate that while the cold-worked tubing would have the best oxidation resistance in a reactor atmosphere, heat treatment in air results in an oxide film which offers good protection to the tubing. The weight of oxide formed, and the percentage which may spall, should be known to evaluate possible hazards due to this oxide being carried round in the coolant steam, irradiated, and finally accumulating in other parts of the circuit, thus restricting access for maintenance. (BBB)

41548 EFFECT OF MOISTURE ON THE OXIDATION OF MILD STEEL AND LOW-ALLOY STEEL IN CARBON DIOXIDE. **Stevens, C. G.; Board, J. (Atomic Power Constructions Ltd., Hounslow, Eng.). Brit. Corros. J., 4: 80-5(Mar. 1969).**

In the advanced gas-cooled reactor (AGR) the reactor coolant contains small quantities of water vapor. Since even very small quantities of water vapor in CO_2 affect the corrosion resistance of mild and low-alloy steels, the effect of different moisture contents and temperatures on the oxidation of a range of low-alloy steels with possible application in the AGR was studied in tests of up to 10,000 hr duration. Attempts were made to improve the oxidation resistance of steels with poor oxidation resistance by the addition of small quantities of Ce to the steel. Tests were carried out at 200 psig and at 500 and 550°C in CO_2–5 vol % CO containing nominally 500, 150, 50, 25, and <10 ppM H_2O. Most of the steels tested exhibited higher oxidation rates at the higher moisture contents. At intermediate moisture contents, edge attack on the specimens contributed up to 70% of the total weight gain. Nominally similar steels showed marked differences in oxidation resistance and Ce additions improved their oxidation resistance. No evidence of Ce sulfide was found in the structures of these steels and it is thought that the improvement in oxidation resistance by Ce is due to its incorporation in the oxide film. The presence of Ce in the oxide may modify the spinel structure and either influence ionic diffusion rates or increase the resistance of the oxide to mechanical breakdown. Before applying the data to assessing the behavior of plain steel surfaces in an AGR, the rates of oxidation were corrected for the contribution from edge attack. The data indicated that in wet gas, the worst steel might be expected to experience high metal losses, while in very dry gas all the steels would give acceptable metal penetrations. Steel E (1 Cr–$^1/_2$ Mo) gave acceptable penetrations even at 550°C in wet gas. (BBB)

41549 HIGH-TEMPERATURE CORROSION OF NIMONIC-75 AND VARIOUS STEELS IN GASES AT LOW PARTIAL PRESSURES. **Knutsen, A. B.; Conde, J. F. G.; Piene, K. (Atomic Energy Establishment, Winfrith, Eng.). Brit. Corros. J., 4: 94-104(Mar. 1969).**

Existing high-temperature gas-cooled (HTGC) nuclear reactors employ graphite as the moderator and structural and canning material of the fuel element, and He as the coolant. The O.E.C.D. reactor experiment first demonstrated the practical feasibility of this engineering concept. This reactor employs ceramic fuel in the form of coated particles as has a coolant inlet temperature of 350°C with an outlet temperature of 750°C. Fuel temperatures may be in the range 1250 to 1500°C and the graphite components may operate at temperatures of up to 1500°C. To evaluate the long-term behavior of constructional and heat-exchange or boiler steels in HTGC coolant environments, a test program was conducted over periods of 10,000 to 20,000 hr. From studies of Nimonic-75 it was concluded that there should be no problem in employing this alloy as a thermal insulating liner in the DRAGON reactor at maximum temperatures of 750°C. The material does not become embrittled and the reduction in strength is insignificant. At higher temperatures (900 and 1000°C) decarburization becomes important in gas mixtures with a net oxidizing power. It was estimated that the thickness of the decarburized zone at 750°C could be about 0.58 mm after 1 yr, rising to 2.6 mm after 20 yr exposure. However, the oxide scales on the surface will act as a barrier and reduce the rate of decarburization. Data on the 10 different steels exposed to the 5-component gas mixture $N_2 + H_2 + CO + CH_4 + H_2O$ (1 : 3 : 3 : 0.5 : 0.5) indicated that this environment has a net oxidizing power. Decarburization was seen on two C–Mn steels, 2.25 Cr–Mo, and 9 Cr–Mo steels. The 12 Cr–Mo–V steel and the austenitic stainless steels showed no decarburization or other structural changes after exposure for 1 week in the 5-component mixture at 750°C. These steels also showed excellent oxidation resistance. Carbon deposition occurred on ferritic materials in the reducing gas mixture $CO + H_2 + H_2O$ (100 : 100 : 1) but appeared to be self-inhibiting. A 10 : 10 : 1 environment was decarburizing to C–Mn steels. Gross effects involving reduction in section thickness were not found on any of the materials tested under any of the conditions. The most significant phenomena in practical environments are decarburization and/or preferential oxidation of certain alloy constituents, but these effects do not result in any catastrophic reduction in mechanical properties or embrittlement. (BBB)

41550 THE EFFECT OF D_2O ON FATIGUE-CRACK PROPAGATION IN A HIGH-STRENGTH ALUMINUM ALLOY. **Wei, R. P.; Landes, J. D. (Lehigh Univ., Bethlehem, Pa.). Int. J. Fracture Mech., 5: 69-71(Mar. 1969).**

Rates of fatigue-crack propagation for a high-strength Al–Zn–Mg–Cu alloy (7075-T651) in an environment of D_2O (99.98% purity) at room temperature were determined and compared with data obtained in high-purity Ar and distilled water. The results showed that D_2O caused a 10-fold increase in the rate of fatigue-crack propagation (up to 10^{-4} in. cycle), which is equal to the increase caused by distilled water. The aggressive environments (D_2O and H_2O) had ample time to reach the crack-tip and hence, environment transport cannot be the rate controlling process. The diffusion of H (or D) ions into the material ahead of the crack-tip is not the rate-controlling step, particularly in view of the fact that the rates of crack growth in D_2O and H_2O were nearly the same. Thus, the results confirm the previous observations that the rate-controlling process is the mechanical process of crack growth. (BBB)

41551 OXIDATION PROTECTION OF REFRACTORY METALS BY INORGANIC COMPOUNDS. **Geschwind, G. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-5-1(1968).**

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

The oxidation of refractory metal powders in the presence of inorganic compounds was followed by differential thermal analysis (DTA) of the metal–compound mixtures in still air at a constant heating rate. The temperature at which oxidation started could be determined, as well as the temperature at which the maximum rate of oxidation of the powder occurred (the explosion temperature). While the initial investigation was concerned primarily with fluoride salts, some other high melting compounds were also studied in conjunction with the refractory metals Ta, Nb, W, and Mo. The salts provided the best protection with Ta; they provided less protection with Nb and W, and almost none with Mo. The largest increases in protection provided by the salts (~200°C) were observed in the systems Ta : LiF, Ta : $NH_4F \cdot HF$, and Nb : KHF_2. The best protection was provided by Li_2O, however, which, besides being the only compound to protect all four metals, increased the protection of Ta and Nb by 300 and 500°C, respectively. Explanations are offered for the protection and its eventual breakdown based on the chemisorption of ions onto the metal surface and the resulting bond between the surface atoms and the adsorbed ions. It is believed that the results open new avenues in the study of oxidation protection. (auth)

41552 INFLUENCE OF THE STRUCTURE OF ZIRCONIUM–COPPER ALLOYS ON THEIR RESISTANCE TO OXIDATION IN CARBON DIOXIDE AT HIGH TEMPERATURES. **Darras, Raymond; Loriers, Henri (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C, 268: 2244-7 (June 30, 1969). (In French).**

After being subjected to quenching from the β phase (1050°C) followed by annealing (700 to 750°C), which gave them a definite structure (Zr_2Cu), zirconium–copper alloys containing 1.6 to 2.5 wt % of copper developed, in carbon dioxide gas at 600°C, more compact layers of oxide that were less sensitive to cracking. (tr-auth)

41553 COMPARISON OF THE CORROSION STABILITY OF TITANIUM-, ZIRCONIUM-, TANTALUM-, AND HIGH MOLYBDENUM-ALLOYED NICKEL MATERIALS IN ACETYLATION MIXTURES. **Weller, J.; Weissgerber, R.; Koehler, W. (Institut fuer Leichtbau und Oekonomische Verwendung von Werkstoffen, Dresden). pp 306-17 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).**

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The corrosion stability of Ti, 0.2% Pt-alloyed Ti, Ti−6% Al−4% V, Ti−6% Al−3% Mo, Ti−5% Cr−3% Al, Ti−5% Al−2% Cr−Mo, Ti−5% Al−2.5% Sn, Ti−4% Al−4% Mn, Ta, Zr, three Ni alloys, and a high Ni−, Cr−, Mo−alloyed steel was studied in a mixture of 55% carbon tetrachloride, 25% acetic acid, and 20% acetic anhydride at 60 and 85°C up to 240 test hrs. It was established that Ta was absolutely stable, whereas Zr was strongly corroded. Ti construction materials slightly alloyed with Al, Mn, Sn, Cr, Mo, and V showed a higher corrosion than pure Ti or 0.2% Pt−alloyed Ti. At 60°C both these materials were comparable to a 28% Mo−alloyed Ni, but at 85°C the addition of 0.2% Pt to the pure Ti was no longer sufficient to obtain the corrosion stability of high-molybdenum Ni alloy. (tr-auth)

41554 CORROSION BEHAVIOR OF Zr–1 Nb AND Zr–2.5 Nb IN PRESSURIZED WATER AND PRESSURIZED STEAM. Beyer, B. (Forschungsinstitut fuer Nichteisenmetalle, Freiberg, Ger.); Juknat, R.; Rauschenbach, R. pp 102-16 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Ger. See CONF-670222.

The corrosion behavior of Zr−1 Nb and Zr−2.5 Nb in pressurized water and pressurized steam was studied. The final heat treatments that resulted in good corrosion behavior in pressurized water were established for both alloys. The melt charge affected both alloys. The effects of Al, Si, and Ti impurities on the corrosion behavior were also studied. The initial results indicated that high Al contents had a sharp effect on corrosion behavior; however, in Zr−2.5 Nb with increasing quenching rate the Al effect was completely suppressed. (J.S.R.)

41555 INVESTIGATIONS OF THE INFLUENCE OF SMALL NITROGEN CONTENTS ON THE CORROSION BEHAVIOR OF Zr–1 Nb IN HIGH-TEMPERATURE WATER AND STEAM. Huettig, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 117-25 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The effects of nitrogen contents of 18 to 343 ppM on the corrosion behavior of Zr−1 Nb in high temperature water and steam were investigated. The studies made in 350°C water showed that the weight increase was independent of the nitrogen content after 2 to 4 days. White oxide was formed on the samples with more than 133 ppM N after 8 days. The studies made in 400°C steam showed that the formation of white oxide occurs after 4 days in the samples with 92 ppM N, after 8 days with 72 ppM, and after 16 days with 56 ppM. The external aspect of corroded samples with varying nitrogen contents showed that the transition to the white oxide occurred at separate small points and not over the entire sample. (J.S.R.)

41556 NICKEL ALLOYS FOR BUILDING UP THE PACKING SURFACES OF PIPE FITTINGS. Frumin, I. I.; Eremeev, V. B.; Subbotovskii, V. P.; Ratner, A. V.; Leonova, L. G. (Inst. of Electric Welding, Kiev). Avtomat. Svarka, No. 9, 26-30(1968). (In Russian).

Normally stellites (cobalt alloys containing Cr, W, Mo, Ni, etc.) are used to build up the packing surfaces of pipe fittings performing in steam atmospheres at up to 650°C, but these alloys are too crack-prone and their application is too difficult. Hence, the applicability of new Ni-base alloys as substitutes for cobalt stellites was investigated, considering that Ni-base alloys containing Cr, B, and Si are widely used to surface equipment parts which must be wear-resistant and operate in corrosive media. Owing to their content of carbides and borides of chromium these alloys display satisfactory resistance to erosion, corrosion and wear. Specimens of the 10 alloys of this kind were subjected to frictional wear tests in a special rig with translational movement of the central specimen with respect to the two other specimens in an atmosphere of 650°C steam as well as to erosion tests for 200 to 300 hr in a stream of water flowing at the rate of 100 to 150 m/sec and corrosion tests in 3% NaCl solution over prolonged periods of time. In addition, their structural stability following 5000 hr of aging at 650°C was determined. Of the Ni-base alloys investigated the optimal alloy proved to be alloy No. 3 (0.4 to 0.6% C, 16% Cr, 1.5% Co, 2.8% Si, 2.8% B, 0.39% Mn, 75.7% Ni, bal. Fe). During operation in a steam atmosphere at ≤575°C and under a unit pressure of 800 kg/cm^2 the wear (scoring) resistance of alloy No. 3 is high and exceeds the corresponding indicator for VZK cobalt stellite. The erosion resistance of the Ni alloys No. 3 and 5 (1.85% C, 0.17% Si, 0.59% Mn, 11.3% Cr, 81.0% Ni, 3% B, bal. Fe) is higher than that of 1Kh18N9T steel. Ni-base alloys display a good corrosion resistance in 3% NaCl solution. The structure of the alloys No. 3 and 5 remains sufficiently stable following prolonged aging at 650°C, but the scoring resistance of alloy No. 5 sharply decreases following prolonged aging 5000 hr at 650°C, whereas the scoring resistance of alloy No. 3 remains high at up to 575°C. (JPRS)

41557 FIELD ION-EMISSION STUDIES OF THE INITIAL STAGES OF TUNGSTEN OXIDATION. Polk, Conrad Joseph. Chicago, Illinois Inst. of Tech., 1968. 151p.

Thesis.

A combined field ion-emission microscope was used to study the initial stages of oxidation on tungsten substrates as a function of the degree of order present on the surfaces. Reactions were conducted in pure oxygen atmospheres in the pressure range of 1×10^{-9} to 6×10^{-6} torr at surface temperatures of 700 and 900°C. Results obtained in the emission microscope demonstrated that the degree of surface order influenced the nucleation of oxide particles which formed on the tungsten surface during the oxidation process and that certain crystallographic regions were preferred as oxide formation sites. Observations of the oxidized surfaces in both the emission and ionization modes of operation also indicated that the oxide particles grew below the metal surface, as evidenced by the presence of deep pits observed during field evaporation of the oxidized surfaces. The presence of these pits indicated that oxygen diffused into the surface to continue the growth of the oxide particle. The results of several oxidation experiments on a tungsten grain boundary are also discussed, which indicated that grain boundaries are not active nucleation sites for oxide formation. (Disser. Abstr.)

41558 WEAR IN ROLLING CONTACT OF THE QUENCHED Cu–Al–Be–Fe ALLOYS. Hori, Masaiti (Kanagawa Univ., Yokohama). Nippon Kinzoku Gakkaishi, 33: 772-5(July 1969). (In Japanese).

The Cu−Al−Be-3.5 Fe alloys quenched in water from 900°C were investigated in relation to the crystal structures, wear resistances, and compositions. The wear test was performed by a rolling contact machine at a sliding speed of 7.85 cm/sec under different loads. It was found that the crystal structures of the quenched Cu-12 Al-(0.6 ~ 1.0) Be-3.5 Fe alloys were β_1 and the wear resistances for the same alloy and the normalized 0.6% C steel at loads 25 ~ 200 kg were better than the quenched Cu-13 Al-3.5 Fe alloy. The quenched Cu-12 Al-(0.6 ~ 1.0) Be-3.5 Fe alloys of high wear resistivity show mirror oxidized wear, but the quenched Cu-13 Al-3.5 Fe alloy shows pear adhesive wear for the same alloy and the normalized 0.6% C steel under loads 25 ~ 200 kg. (auth)

Preparation and Fabrication

Refer also to abstracts 40848, 40917, 40929, 41626, and 42500.

41559 (AD–684030) A REEXAMINATION OF THE NUCLEAR PROLIFERATION PROBLEMS PRESENTED BY WORLD-WIDE REQUIREMENTS FOR ENRICHED FUEL, RELATING THE FEBRUARY 1965 OPTIONS TO TODAY. Kramish, A. (RAND Corp., Santa Monica, Calif.). Aug. 1968. 17p. (P–3923). CFSTI.

The current upsurge of serious interest in several European nations, Japan and elsewhere, in acquiring domestic or regional facilities for the production of ^{235}U for nuclear power plants, coupled with expression of the desire of U.S. industry to acquire private ownership and operation of government uranium enrichment facilities makes it imperative that policy on such facilities be reexamined now in all of its facets. Technical developments that could lead to a proliferation of independent natural nuclear weapon capabilities are discussed. The vigor and meaning of the Non Proliferation Treaty will be profoundly affected by the nature of the solutions of the fuel problem, and regions other than Europe must also be considered. Some of the action options, or variants, which were available three years ago are beginning to vanish. (auth) (USGRDR)

41560 (BNWL–1100) DEVELOPMENT AND FABRICATION OF REFRACTORY METAL MICROBALLOONS. Sump, K. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

The deposition of refractory metals upon expendable microspherical substrate to form thin-walled refractory metal microballoons was successfully demonstrated. Both tungsten and rhenium were deposited upon these spherical cores by the process of chemical vapor deposition. The substrate was removed by heating in a vacuum environment to leave the refractory metal microballoons. (auth)

41561 (CONF-681064-8) TUBES FOR NUCLEAR PLANTS. Wright, R. (Tube Investments Ltd., Walsall (England). Steel Tube Div.). [1968]. 13p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

The wide range of materials, fabrication processes, sizes, and special types of tubes produced by British tube manufacturers is summarized. Experience in the production and quality control of tubes with integral and with welded-on fins is discussed. (UK)

41562 (EURAEC-2047) STAINLESS STEEL CLADDING OF VERY THICK STEELS. Quarterly Report No. 14, October 1-December 31, 1967. (Ghent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). Contracts 040-61-9-RDB; 008-63-12-TEEB-RD. 53p. (EUR-3991). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Cladding test results using AISI 308 ELC tape-type sheets and various fluxes with different Cr contents are reported. Results clarified optimization parameters for dilution of metals deposited by contribution of the base metal. Other factors related to cladding dilution variations and flux consumption were identified. The flux consumption factor was found to be a function of the arc voltage. (J.R.D.)

41563 (INR-1049) DIFFUSIVE SULPHURATION OF STEEL WWN1 USED FOR MATRIXES WORKING IN INCREASED TEMPERATURES. Kochanski, Tadeusz (Institute of Nuclear Research, Warsaw (Poland)). 1968. 16p. (In Polish). Dep.

The sulfurization of steel WWN1 used for matrixes for cladding fuel elements was done to increase immunity against wear of rubbing surfaces. The results of metallographic observations, hardness measurements, and immunity are described. (auth)

41564 (KFK-910) SAFEGUARDS MEASURES AND EFFORTS IN CONCEPTUAL FABRICATION PLANTS FOR URANIUM AND PLUTONIUM CONTAINING FUEL ELEMENTS. Gupta, D.; Gmelin, W.; Kraemer, R.; Richter, K.; Schneider, V. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Apr. 1969. 42p. (CONF-690420-1). Dep.

From Panel on Safeguards Methods for Conversion Plants and Fuel Fabrication Plants, Vienna, Austria.

Some estimates have been made on the growth of fabrication demands in Germany in the coming years. Measuring methods which could be of interest for fabrication plants, are discussed. Some conceptual designs of fabrication plants have also been presented which have been specially prepared to analyze and incorporate various safeguards requirements based on the principle of controlling the flow of fissile material at strategic points. Finally, the total efforts required in implementing all the safeguards measures at these strategic points have been estimated for these plants. (J.C.W.)

41565 (ORNL-TM-2576) EXPERIMENTAL FABRICATION OF ZIRCALOY-4 TUBING. Nilsson, T. M.; Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 23p. Dep. CFSTI.

The planning of 12 fabrication schedules for Zircaloy-4 tubing and the manufacture of tubing according to these schedules are described. The tubes are being used in a study of the influence of fabrication variables on crystallographic texture and anisotropy of mechanical properties. Extruded tube shells were fabricated to final size by tube reducing and by combinations of tube reducing and drawing, planetary swaging, and hammer swaging. Under constant annealing conditions, the grain size of the finished annealed tubing seemed to depend primarily on the amount of cold work or the cold-working sequence. Other fabrication variables seemed to be of only minor importance. (auth)

41566 (UCRL-71844) SHEARING OF BULK Cu, Be, AND W UNDER NEARLY HYDROSTATIC PRESSURES TO 70 KILOBARS. Abey, A. E. (California Univ., Livermore. Lawrence Radiation Lab.). July 11, 1969. 10p. (CONF-690908-1). Dep. CFSTI.

From International Conference on the Physical Properties of Solids Under Pressure, Grenoble, France.

A new apparatus has been developed to shear bulk metal samples at pressure up to 70 kbar. The apparatus is explained in detail and some data for Cu, Be, and W are presented. (auth)

41567 (Y-1678) EFFECT OF IRON ON FISSURING OF URANIUM WELD METAL. Turner, P. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 11, 1969. Contract W-7405-eng-26. 186p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

An investigation was conducted to determine the effects of dilute alloying additions of iron on the hot-cracking tendency of uranium weld metal, since the maximum impurity level of iron that can be tolerated without causing fabrication problems has not been well defined. Therefore, an arc-spot Varestraint test device was built and utilized for determining the susceptibility of laboratory-scale specimens to hot cracking. The specimens were prepared by doping electron-beam welds with iron in calculated amounts. Iron compositions ranged from nominally 50 ppM (0.005 wt %) to 7,700 ppM (0.77 wt %). The intermediate iron alloys were the most sensitive to hot cracking. Weld metal with iron contents at the upper and lower ends of the range of compositions were resistant to hot cracking. Welds containing less than 600 ppM (0.06 wt %) iron were not prone to hot cracking at any of the strain levels studied. Weld metal with less than 900 ppM (0.09 wt %) iron did not crack at strain levels normally encountered in weldments. However, subsolidus cracking in zones heated within the β-phase temperature range was observed at strain levels that are characteristic of forming processes. This type of cracking appeared to be independent of iron composition and rarely occurred at low strains. Metallography, fractography, and electron microprobe analysis results indicated that cracking was caused by a liquid film which persisted on cooling to form U_6Fe and possibly UFe_2 along grain and solidification subgrain boundaries of the primary (γ) phase. In this light, a model for hot cracking of uranium-iron peritectic alloys is proposed. Correlation of results of the Varestraint test with those of weld tests revealed that hot cracking was dependent on the welding conditions as well as on iron composition. Information and drawings pertaining to the fabrication and operation of the modified Varestraint test device are included. (J.R.D.)

41568 NICKEL BASE ALLOY. Pohlman, Marvin A.; Moore, Joseph B. (to General Electric Co.). U. S. Patent 3,457,066. Filed Apr. 10, 1959.

A nickel base alloy is described consisting essentially of 14.0 to 17.0% chromium, 13.0 to 20.0% cobalt, 3.25 to 3.75% titanium, 4.0 to 4.5% aluminum, 0.02 to 0.04% boron, and 4.50 to 5.50% molybdenum, the balance being nickel. (Offic. Gaz.)

41569 HIGH PRESSURE CRYSTAL GROWTH OF ALPHA PLUTONIUM. Liptai, R. G.; Friddle, R. J. (Argonne National Lab., Ill.). J. Cryst. Growth, 5: 216-18(1969).

Large single crystals of alpha plutonium were grown from the solid-state phase transformation beta to alpha at pressures of 55 kbar. The sample was cooled through the phase transformation between 480 and 400°C at a rate of 40°C/hr, annealed at 400°C for several days, cooled to room temperature, and then depressurized. (auth)

41570 METALLIDING. Cook, Newell C. Sci. Amer., 221: No. 2, 38-46(Aug. 1969).

A process for associating or alloying metals is described which involves diffusing atoms of one metal into the surface of another. The diffused metal becomes an integral part of the surface of the other metal, instead of being only mechanically attached to the surface as in plating. A periodic table of the elements is included to indicate the 24 metalliding reactions which have been studied. It is noted that there are about 36 more metals whose fluorides are stable enough for use in metalliding. (J.R.D.)

41571 THE TRANSPORT AND DEPOSITION REACTIONS INVOLVED IN THE PRODUCTION OF ZIRCONIUM COATINGS FROM MIXED IODIDE VAPOURS. Sale, F. R. (Univ. of Sheffield, Eng.). J. Less-Common Metals, 19: 53-62(Sept. 1969).

The transport and deposition mechanisms involved in the production of zirconium coatings by a flow iodide process have been considered with reference to the results of studies on the thermodynamic properties of zirconium tetraiodide, triiodide, and diiodide. The possible sponge bed reactions are analyzed so that the components of the mixed-iodide vapor stream can be identified, and the concomitant disproportionation of zirconium diiodide, and thermal decomposition of tetraiodide, is proposed as the mechanism by which the low-temperature deposition of zirconium takes place. (auth)

41572 PREPARATION OF TRANSMISSION ELECTRON MICROSCOPY SPECIMENS FROM TUBING. DuBose, C. K. H.; Jones, C. (Oak Ridge National Lab., Tenn.). Metallography, 2: 31-9(Mar. 1969).

The application of transmission electron microscopy to engineering materials requires techniques for preparing specimens from intricate structures. Suitable flat tabs can be cut or ground from massive pieces and thinned by using standard techniques, but small-diameter, thin-wall tubing presents special problems that cannot be handled in this way. Modifications to a jet polishing technique that enable good specimens to be rapidly and reliably prepared from tubing using a minimum of material are described. Special features of a glove-box facility for thinning alpha-contaminated materials are also described. (auth)

41573 GENERAL ASPECTS OF THE BELGIAN ACTIVITIES. Seynaeve, M. F. (Industrie Nucleaire, Brussels). Atompraxis, 15: 149-51(May-June 1969). (In French).

Since the turn of the century Belgium has acquired experience in the mining and processing of radioactive materials. Moreover very extensive and highly diversified industrial plants covering the whole range of production capacity in the nuclear field are available. Various bodies concerned with atomic energy exist in Belgium: at the university level the Interuniversity Institute of Nuclear Science, at the official level the Commissariat for Atomic Power, for research work the Nuclear Power Research Center CEN, at the professional level the Nuclear Industry Professional Association and the Nuclear Foundation. With respect to nuclear industry Belgium produces UO$_3$ and uranium metal and has built a large plant for the production of reactor fuel elements cores and control rod mechanisms. A laboratory has existed since 1958 for the production of plutonium. Complete power plants of the PWR type are built in Belgium. A spectral shift reactor "The Vulcain" conceived by a Belgian engineer is experimentally successful. An association was established between Germany, Belgium, and Holland for the construction of a sodium fast reactor of 1000 MW$_{el}$. Belgium participates also with Germany, Italy, and the United Kingdom in Inter Nuclear for the exploitation of high temperature gas reactors. (auth)

41574 WROUGHT CHROMIUM BASE ALLOY. Chang, Winston H. (to General Electric Co.). U. S. Patent 3,458,366. Filed Oct. 1, 1965.

A wrought dispersion strengthened chromium base alloy is provided with improved resistance to oxidation nitrification and scaling and with improved ductility by producing in the grain boundaries, in the absence of carbides of titanium and chromium, a discontinuous zirconium carbide which acts as a strengthening mechanism, as a matrix scavenging agent and as an oxidation and nitrification inhibitor. Also included are the elements yttrium and thorium for added oxidation resistance. (Offic. Gaz.)

41575 UTILIZATION OF PLUTONIUM AS NUCLEAR FUEL. Vanden Bemden, E. (Belgonucleaire, Brussels). Atompraxis, 15: 162-5(May-June 1969). (In German).

Control in the fabrication of Pu enriched fuel in Belgium is discussed. The CEN-BN Association has research and development laboratories operating in Mol which permitted BN to establish a test unity for the production of plutonium enriched fuel. Due to the adoption of adequate equipment, control techniques, and working methods it was possible to prove that plutonium compounds can now be treated on an industrial scale in complete safety. (auth)

41576 PREPARATION OF ELECTRON-MICROSCOPY SPECIMENS OF CADMIUM OF SELECTED ORIENTATION. Kirchner, H. O. K. (Cambridge Univ., Eng.). J. Inst. Metals, 97: 256(Aug. 1969).

Slices 1 mm thick were spark-machined from single crystals, and polished on both sides simultaneously by electrolytic jet. The discs were repolished electrolytically until just perforated in a nitric acid solution. (UK)

41577 AN INVESTIGATION OF THE FATIGUE BEHAVIOR OF A BORON-EPOXY-REINFORCED TITANIUM COMPRESSOR DISK. Mangiapane, J. A.; Sattar, S. A.; Profant, D. D. (United Aircraft Corp., East Hartford, Conn.). Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-5-2(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

The success of an experimental evaluation of a boron-epoxy-reinforced titanium compressor disk prompted the investigation of the fatigue behavior of a similar composite disk. The new disk benefitted from a design modification which decreased the weight to approximately 60 percent of that of present engine disks. In addition, the modified design permitted the bolt holes in the disk to be eliminated, thereby eliminating a source of high stress concentration. The fabrication procedure was similar to that used for the previous disk. It consisted of winding continuous boron filament in each of two grooves in a titanium alloy (Ti-6Al-4V) ring while applying epoxy resin by brush. The completed disk was instrumented, assembled with a full set of conventional titanium blades, and mounted in a spin pit. The bladed disk was then cycled between speeds of 2000 and 11,750 rpm, which is the design speed. A 2000-cycle test was planned, but testing was terminated after 1674 cycles because of a malfunction of the speed control valve, which resulted in overspeeding of the disk. Although the planned program was not completed it was felt that sufficient testing had been performed to demonstrate the advanced filament-reinforced composite structures can be designed with adequate fatigue strength for engine compressor applications. (auth)

41578 JOINING TECHNIQUES FOR THORIA DISPERSION STRENGTHENED MATERIALS. Yount, R. E. (General Electric Co., Evendale, Ohio). Sci. Advan. Mater. Process Eng. Proc., 14: Paper II-2B-1(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

Several joining methods for fabricating thoria dispersion-strengthened nickel and 80 Ni-20 Cr have been critically evaluated over the past four years. Generally, vacuum brazing with specially developed filler metals appears best. Full scale jet engine hardware has been fabricated of these new alloys and successfully engine tested. (auth)

41579 VACUUM BRAZING: A JOINING MEDIA OF THE SIXTIES. Schwartz, Mel M. (Martin Marietta Corp., Baltimore). Sci. Advan. Mater. Process Eng. Proc., 14: Paper II-2B-2(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

The most significant changes in brazing within the last several years have been the exclusion of fluxes and the trend toward porosity-free vacuum-tight joints. These changes have resulted in the extensive use of vacuum brazing for joining the new metals and their alloys as well as non-metal applications. The types of brazing furnaces in use, the heating elements and shields, and the tooling requirements which are critical due to the vapor pressure of various materials are discussed. Vacuum brazing of aluminum alloys and beryllium and titanium alloys are discussed in detail including new braze alloys and several current applications including the hardware produced. The family of superalloys in addition to the new thoria-dispersioned nickel and nickel-chromium are discussed and the refractory metal family where brazing temperatures of 4140°F have been used to produce tantalum alloy structures. In this discussion will be included the various braze alloys, cleaning procedures, parting agents and stop-off materials, compatibility with coatings subsequently applied, strengths at elevated temperatures (2000 to 3000°F) depending on the metal and structural hardware. Aside from the final operation of vacuum brazing, a description and detailed discussion of the solution of several problem areas will precede each of the selected assemblies for each material selected. The problem areas include the forming and fusion welding of niobium and titanium alloys prior to brazing, the fabrication of tantalum alloy honeycomb by resistance welding methods and similarly for TD-Nickel and the cleaning of aluminum alloys. The joining of dissimilar metal and non-metal combinations is another area where brazing has excelled. In conclusion, the future of vacuum brazing and its effects on the various media for joining today is elaborated on as well as several significant contributions and advantages to be gained. (auth)

41580 NEW PREALLOYING TECHNIQUE IMPROVES PROPERTIES AND PROCESSING OF REFRACTORY METAL POWDERS. Ind. Heat., 36: 230-1(Feb. 1969).

Prealloyed W-Re and Mo-Re are now available as homogeneous powder metal of small grain size and high purity. Greater powder homogeneity permits sintering at lower temperatures for shorter time periods and reduces the sigma phase in the fabricated alloy. Use of Re as an alloying element provides ductility, good high-temperature strength, high melting point, favorable electrical properties, and good corrosion resistance. (Metals Abstr.)

41581 STUDY ON THE PROPERTIES OF 2¼ Cr-1 Mo WELD FORMED MATERIAL. Ujiie, Akira; Nagaoka, Tomokichi (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Mitsubishi Juko Giho, 6: 430-8(July 1969). (In Japanese).

An outline is presented of the recently developed weld forming techniques with emphasis on fabrication. In order to apply this technique to production, an investigation was conducted on the properties of weld material made from 2¼ Cr-1 Mo, a widely used material for pressure vessels of hydrogen cracking reactors, which confirmed that the material has similar or even better properties than rolled material and is well suited for the manufacture of pressure vessels. (auth) (NSA of Japan)

41582 ON THE PRODUCTION OF STEEL AND ALLOY TUBES FOR NUCLEAR POWER PLANTS. Ogura, Seiitsu; Suzuki, Jun (Sumitomo Metal Industries Ltd., Osaka). Sumitomo Kinzoku, 21: No. 2, 59-74(Apr. 1969). (In Japanese).

Along with the rapid development of nuclear power for electric power generation, five modern nuclear power plants are under construction in Japan. In these nuclear power generating plants, various pipes and tubes which belong to new type from view points of material, dimension, and shape are used. Zircaloy fuel cladding tubes, large diameter and heavy walled austenitic stainless steel pipe and fittings (main coolant piping for P.W.R. or recirculation piping for B.W.R.), and HN75 (Inconel 600) tubes for steam generator are typical examples. Production and the quality control methods for these pipes and tubes have been established. The production method and test results on prototype products or characteristics of those materials are described. (auth) (NSA of Japan)

41583 THERMODYNAMIC BASIS OF THE PROCESS FOR REDUCTION OF LANTHANUM TRIFLUORIDE BY CALCIUM. Bayanov, A. P.; Serebrennikov, V. V. (Tomsk State Univ., USSR). Zh. Fiz. Khim., 43: 1407-9(June 1969). (In Russian).

Thermodynamic calculations for the reduction of lanthanum fluoride by calcium indicated that the process of obtaining metallic lanthanum occurs with a satisfactory yield at temperatures below 1755°K. (tr-auth)

41584 METHOD OF MAKING A NUCLEAR FUEL ELEMENT. McClintock, Donald R. (to Westinghouse Electric Corp.). U. S. Patent 3,460,237. Filed Dec. 20, 1966.

A method is disclosed of joining a plug, having a land, to tubular cladding for nuclear fuel. The tubular cladding is very thin, about .010 inch, and may be composed of stainless steel. The joining is effected by fusion tungsten-arc welding with the welding arc impinging at the junction of the land and outer extension of the plug. (Offic. Gaz.)

41585 METHOD OF MAKING NUCLEAR REACTOR FUEL ELEMENTS. Shoudy, Albert A. Jr. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,460,236. Filed Apr. 20, 1967.

A method of fabricating a nuclear fuel element includes the filling of a tube with fissionable fuel material, securing end closures to the ends in sealed relationship, creep collapsing the tube onto the fuel material, making a hole in at least one of the end closures, and attaching an axial fission gas plenum to that end closure. (Offic. Gaz.)

41586 PECULIARITIES IN THE WELDING OF TITANIUM, ZIRCONIUM, AND MOLYBDENUM. Marquardt, E. (Zentralinstitut fuer Schweisstechnik, Halle, Ger.). pp 175-85 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The gas shield device used in the welding of titanium and the welding conditions are briefly described. Results obtained in the welding of Zr−1 Nb with the same device are reported. Corrosion and mechanical testing was done on the weld, before and after annealing. TIG point welds were also made on this alloy with satisfactory results. The welds on Mo exhibited pores on either side of the weld in x-ray and metallographic studies. (J.S.R.)

41587 ELECTRON-BEAM MELTING OF HIGH-MELTING AND REACTIVE METALS (Ti, Zr, V, Nb, Ta). Bohmeier, H. (Forschungsinstitut fuer Nichteisenmetalle, Freiberg, Ger.). pp 192-210 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The advantages and disadvantages of the electron-beam melting of Ti and Zr were compared with those of the vacuum arc furnace. For large production quantities, the vacuum arc furnace offers the advantages of lower investment and maintenance costs, simple maintenance, faster operational preparation, and very high operational safety. In the electron-beam melting of V, Nb, and Ta there is a sharp decrease of the gas and carbon content of the metals. The melt loss, due to spattering and evaporation, was dependent on the gas content of the initial material. (J.S.R.)

41588 PROBLEMS IN THE PRODUCTION AND DEGASSING OF VANADIUM. Varhegyi, G.; Vitanyi, P.; Vassel, K. R. (Forschungsinstitut fuer Nichteisenmetalle, Budapest). pp 211-27 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

Studies were made on the development of equipment and procedures for the production of degassed V by reduction of VCl_3 with liquid Mg with a production capacity of 100 kg V per year. The possible impurity sources and the mechanisms of the various processes were investigated. The properties of the reduction product were determined, and its further processing is described. The morphology of the vanadium sponge was determined. The briquetting of the sponge, the hydrogen degassing, the sintering, and the melting procedures are discussed. The melt product yielded a ductile V, which could be cold worked at room temperature without heat treatment. (J.S.R.)

41589 PRODUCTION AND SOME PROPERTIES OF SINTERED AND MOLTEN TANTALUM. Schreiter, G. (Forschungsinstitut fuer NE-Metalle, Freiberg, Ger.). pp 228-39of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The properties of Ta sheets prepared by various methods were studied. Ta powder produced by magnesium reduction of the chloride was compressed and sintered. After cold rolling the sheets were subjected to a second sintering. The powder to be used in electron beam melts was first compressed and then sintered in high vacuum. The molten blocks were cold-worked and recrystallized annealed. The mechanical and recrystallization properties of the Ta sheets prepared in the two ways differ from each other. In the molten Ta sheets there is an inhomogeneous structure after high degrees of deformation. (J.S.R.)

41590 SINTERING BEHAVIOR OF W–Re–ThO_2 POWDER. Staudt, J.; Knecht, Ch. (VEB Berliner Gluehlampenwerk, Berlin). pp 318-24 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The W−Re−ThO_2 powder to be sintered is obtained by a mixed crystallization of ammonium paratungstate, ammonium perrhenate, and thorium hydroxide. The mixed crystal is then reduced to the powder. The addition of Re to the ammonium paratungstate accelerates the reduction procedure. The reduction process was studied quantitatively by gravimetric and BET methods. The reduction product of porous particles was sintered at 1600°C under hydrogen. The dependence of the density on the Re content was determined. The compression phenomena are under additional study, but the sintered powder had rapid compressibility. (J.S.R.)

41591 BRAZING ALLOYS. Crooks, Donald David; Kelsey, Royal Winston; Sumsion, Henry Theodore (to Secretary of the Navy). British Patent 1,162,098. Aug. 20, 1969. Filed Sept. 1, 1966.

A method of brazing, bonding or otherwise joining graphite and/or other ceramic material using binary alloys is described. Various compositions using the elements Be, Fe, Ta, Ti, Zr, V, Nb, Cr, and Mo are listed. These alloys exhibit a high degree of wettability and fluidity and provide a wide choice of melting points from about 900 to greater than 2000°C. (J.R.D.)

41592 SIMPLIFIED WELDING TECHNOLOGY OF 13CrMo44 AND 10CrMo910. Schubert, Jochen; Schmidt, Wolfgang. ZIS (Zentralinst. Schweisstech.)-Mitt., 10: 1891-1909(Nov. 1968). (In German).

The possibility of omitting or simplifying the post-welding heat treatment when welding 13CrMo44 and 10CrMo910 was investigated. Welded joints were produced using gas and W-inert gas [WIG] welding and their UTS, YP, hardness curves, and creep strengths were determined. The mechanical and creep properties of the WIG welded materials were satisfactory for the as-welded condition. Gas welding 13CrMo44 produced an embrittled joint with unfavorable creep properties. For 10CrMo910 a post-welding heat treatment at 750°C was necessary. (Metals Abstr.)

41593 VACUUM DEPOSITION IN A HIGH VACUUM: THIN FILMS ON METALS, PLASTICS, AND PAPER. VDI (Ver. Deut. Ing.) Nachr., 23: No. 12, 2(Mar. 19, 1969). (In German).

A brief review of the potentialities of the deposition of metals in a high vacuum, between 10^{-5} and 10^{-8} torr, is presented. The most common metals used for this process are: Cd, Zn, Ag, Au, Ge, Al, W, Ni, and Ta. Uses of these deposits in the various branches of physics, nuclear-, electrical-, and constructional-engineering, corrosion protection, and space research are indicated. (Metals Abstr.)

41594 CARBON REDUCTION PROCESS. Wilhelm, Harley A.; McClusky, James K. (to U. S. Atomic Energy Commission). U. S. Patent 3,463,634. Aug. 26, 1969.

A process is described for reducing uranium or vanadium oxides to high-purity metal by heating under reduced pressure a mixture of the metal oxide and carbon to form an electrically conductive intermediate. This intermediate is then heated by self-induction under reduced pressure in a ceramic crucible until reduced to the metal. (AEC)

41595 THE HEAT-TREATMENT OF VANADIUM, NIOBIUM, AND TANTALUM BY ELECTRON BEAM. Izotov, V. M.; Krupin, A. V.; Mel'nikova, L. V.; Solov'ev, V. Ya.; Chernyshev, V. N. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 28, 13-17(1968). (In Russian).

A study of the mechanical properties and microstructures was used to establish the optimum regimes of heat treatment as a function of the degree of deformation of sheet products of Nb, Ta, and V. (Referativyni Zh.)

41596 MECHANISMS OF Mo-Mn-Ti METALLIZING AND Cu BRAZING IN METAL-TO-CERAMIC SEALS. Hirota, Minoru (Kobe Industries Corp., Akashi, Japan). Trans. Jap. Inst. Metals, 10: 98-106(Mar. 1969).

An increasing emphasis on reliability of metal-to-ceramic seals has focused more attention on Mo-Mn-Ti metallizing and Cu brazing. In response to these trends, the bonding mechanisms of Mo-Mn-Ti metallizing and Cu brazing were studied by means of the seal strength test, the heat cycle test, optical and electron microscopic observations, and electron probe microanalysis. The bonding of the Mo-Mn-Ti metallizing can be considered to consist of three different mechanisms; the primary bonding due to the formation of the reaction product layer; the secondary bonding due to the migration of the glassy phase; and the tertiary bonding due to the sintering of the metallized layer itself with a reactive liquid. Complete bonding was accomplished by tertiary bonding. Various theories proposed hitherto are thought to be an interpretation only for the primary or secondary bonding. Also, the Cu brazing contains a phenomenon associated inevitably with its high temperature processing. This is the reason for the rapid decrease in both seal strength and vacuum tightness in the Cu brazed metal-to-ceramic seals by the heat cycling. (auth)

41597 CAST NICKEL-BASE ALLOY. Bieber, Clarence George; Galka, John J. (to International Nickel Co., Inc.). U. S. Patent 3,459,545. Filed Feb. 20, 1967.

A description is given of a nickel-base alloy particularly useful in the form of castings such as in the form of turbine blades and characterized by an improved resistance to corrosion due to the combined effects of chlorides and sulfur while retaining high creep strength at elevated temperatures. A preferred alloy contains about 16% chromium, 10% cobalt, 2% molybdenum, 2.5% tungsten, 1% niobium, 1.25% tantalum, 4% aluminum, 3% titanium, 0.18% carbon, 0.02% boron, 0.1% zirconium, and the balance essentially nickel. (Offic. Gaz.)

41598 PROCESS OF PRODUCING BERYLLIUM METAL POWDERS. Morana, Simon J.; Koshuba, Walter J. (to Kawecki Berylco Industries, Inc.). U. S. Patent 3,460,999. Filed July 1, 1966.

A method is described for producing beryllium metal powders substantially devoid of beryllium oxide wherein the beryllium metal powders are milled in a non-halogenated hydrocarbon vehicle and subsequently the powders are separated from the vehicle. The powders can then be exposed to air under controlled conditions to produce non-pyrophoric beryllium metal powders that will not combust at normal atmospheric conditions. (Offic. Gaz.)

Properties Evaluations

Refer also to abstracts 40941, 41556, 41567, 41568, 41577, 41578, 41595, 41653, 41726, and 42475.

41599 (AECL-3361) THE STRESS-RUPTURE PROPERTIES OF HEAT-TREATED ZIRCONIUM-2.5 PERCENT NIOBIUM ALLOY. Ibrahim, E. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1969. 13p. Dep. CFSTI (U. S. Sales Only). CAN $0.50.

Stress-rupture tests at 300 to 450°C on specimens from pressure tubes of heat-treated Zr-2.5% Nb are reported. The calculated rupture stress for 30 years at 300°C is 49.2 kpsi (34.6 $\mathrm{kgf/mm^2}$). This is greater than cold-worked Zircaloy-2 but less than cold-worked Zr-2.5% Nb alloy. The effect of temperature and time to rupture on rupture ductility is analyzed using a Larsen-Miller parameter for heat-treated Zr-2.5% and compared with results on cold-worked Zircaloy-2 and cold-worked Zr-2.5% Nb. (auth)

41600 (AECL-3362) PROSPECTS FOR ZIRCONIUM STRUCTURAL ALLOYS AT HIGH TEMPERATURES. Thomas, W. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1969. 13p. (CONF-690615-4). Dep. CFSTI (U. S. Sales Only). CAN $0.50.

From 9th Annual Nuclear Association Conference, Montreal, Canada.

Improved station efficiencies and lower capital costs provide incentives for the development of zirconium alloys for pressure tubes which can operate at temperatures above 450°C. The experience of the Ti industry indicates that a complex alloy containing solution hardeners of Sn or Al and precipitation hardeners of Mo and Nb and perhaps Si will be required. The thermal neutron cross-section of the alloy will be about 10% higher than Zircaloy-2 and because of its poor corrosion resistance will require cladding with a corrosion resistant alloy such as Zr-Cr. Results indicate that such a pressure tube is feasible. (auth)

41601 (EURAEC-2085) A NEW DETERMINATION OF THE EMBRITTLEMENT IN STEEL USING SMALL SPECIMENS (~0.2 cc) IN PARTICULAR WITH RESPECT TO IRRADIATION. Progress Report, July 1-December 31, 1968. Koning, C. (Metaalinstituut TNO, Delft (Netherlands)). Jan. 28, 1969. Contract 060-64-11-TEEN. 26p. (EUR-4007; M-69-81). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

Cylindrical test samples with diameter and length 6 mm of pressure vessel steels such as T1-U.S.S., 3.5 DFOV, Soudotenax 56, HSB 55 C and 1.2 MD 07 were quasi-statically compressed at temperatures ranging from -50 to +180°C. The dependence of yield strength, ductility and absorbed energy on temperature at these static compression levels were evaluated from recorded load-compression diagrams. The dynamic yield strength as a function of temperature in non-irradiated and four irradiated conditions can be evaluated from the oscillograms, already obtained in the stress wave attenuation tests for reactor pressure vessel steels such as T1-U.S.S., Soudotenax 56, HSB 55 C, and 1.2 MD 07 in the low temperature irradiation program. Using these evaluations a comparison with the static yield strength in non-irradiated condition can be carried out. (auth)

41602 (GAMD-9056) COATING CONTAMINATION IN LONG-TERM-ANNEAL BISO PARTICLES. Steward, K. P. (Gulf General Atomic, Inc., San Diego, Calif.). June 30, 1969. Contract AT(04-3)-633. 33p. Dep. CFSTI.

Long-term-anneal BISO particles showing different amounts of radiographically detectable contamination at the particle surfaces have been picked out, sectioned, and analyzed using the electron microprobe. The contamination, visible on the radiographs as bright rings at the particle surface, arose from core migration outwards rather than from an external source. The heavy metal concentration in these rings was up to about 40% by weight relative to the pyrolytic carbon (PyC). The thorium and uranium concentrations within the rest of the PyC were relatively constant and only a few hundredths weight percent in each case. The limit for radiographically detecting heavy metal in PyC was close to 1 wt %. After the particles were leached, rings of contamination in the particles (which correspond to the most contaminated particles originally) were observed only in conjunction with core migration. In particles exhibiting partial core migration, the heaviest contamination (brightest part of the ring) was adjacent to the region of core migration. Significant core migration occurred only where a core seal or rejected carbon layer was not evident. The mechanism whereby the thorium and uranium diffuse to and build up just beneath the particle surfaces is probably due to oxygen pickup by the particles. Several weight percent oxygen at the periphery of the particles with the brightest rings was detected with the electron microprobe. This indicates "trapping" of uranium and thorium near the particle surfaces as oxides which have much lower free energies than the $(Th,U)C_2$ in the core. (auth)

41603 (GEMP-686) STRESS-STRAIN BEHAVIOR OF SEVERAL STAINLESS STEELS TO ELEVATED TEMPERATURES. Conway, J. B.; Berling, J. T.; Stentz, R. H.; Salyards, D. G. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). May 1969. Contract AT(40-1)-2847. 218p. Dep. CFSTI.

Results of measurements of the low-cycle fatigue characteristics of AISI 304, 316, and 348 stainless steels at 430 to 816°C are presented. Particular attention was directed toward the relations between low-cycle fatigue behavior, short-term tensile properties, and prediction of low-cycle fatigue in a material based on knowledge of its short-term tensile properties. (J.R.D.)

41604 (MSAR-69-139) EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. TOPICAL REPORT NO. 14. MSAR EVALUATION OF CANDIDATE FERRITIC ALLOYS FOR LMFBR SERVICE. Hiltz, R. H.; Kirschler, L. H. (MSA Research Corp., Evans City, Pa.). July 1969. Contract AT(11-1)-765. 40p. Dep. CFSTI.

It was found that titanium is an effective stabilizer for carbon in the ferritic steels. The Nb–Ta composition utilized by Thyssen tube works also appears to be effective in holding carbon. Vanadium is a borderline material. The titanium-stabilized 5 Cr-½ Mo material was selected for further testing. The Nb–Ta stabilized material has seen sufficient trouble-free exposures in European work at 1050°F consistent with practical operation that it should be considered. Sufficient work must be accomplished to assure that the abnormal behavior observed in this steel at 1200°F and 3000 plus hours does not occur at lower temperature at longer times, particularly under the time-operating parameters to be imposed in American fast breeder reactors. It appears that the standard 2¼ Cr-1 Mo alloy is approaching an equilibrium condition with respect to the austenitic materials in this particular system at a carbon content of ~200 ppM. This value will be further defined shortly upon removal of the 10,000-hour exposed materials from MSAR systems. In one 1000 MWe design study, the current design for secondary systems is based upon using the 2¼ Cr-1 Mo alloy and allowing it to decarburize and upgrading the material thickness to account for the loss in strength caused by decarburization. If an economical containment is to be designed to a lower strength limit of a decarburized Cr–Mo, then a better approach to the problem could be utilizing a 2¼ Cr-1 Mo alloy with a low initial (200 ppM) carbon level. This would not detract from the over-all performance but would eliminate the upstream transport of carbon embrittling the austenitic structure. (auth)

41605 (ORNL-tr-2171) CONCENTRATION CHANGES IN BINARY METAL–GAS SOLUTIONS DURING SIMULTANEOUS REMOVAL OF GAS AND EVAPORATION OF METAL. II. DISCUSSION OF THE CONCENTRATION CHANGES IN THE SYSTEMS VANADIUM–OXYGEN, NIOBIUM–OXYGEN, TANTALUM–OXYGEN, NIOBIUM–NITROGEN, VANADIUM–NITROGEN, AND TANTALUM–NITROGEN. Hoerz, Gerhard. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Metallk., 60: 121-6(1969). 12p. Dep. CFSTI.

Using thin samples the degassing kinetics in the systems vandium-oxygen, niobium-oxygen, tantalum-oxygen, niobium-nitrogen, and tantalum-nitrogen were determined and compared with the results of the theoretical treatment of the concentration changes in metal-gas solutions during annealing. It is found, that in the systems niobium-oxygen, tantalum-oxygen, niobium-nitrogen, and tantalum-nitrogen the metal evaporation is negligible during almost the whole degassing process up to the melting temperature. In the system vanadium-oxygen metal evaporation is negligible only during a part of the degassing process. In the systems vanadium-oxygen, niobium-oxygen, tantalum-oxygen, niobium-nitrogen, and tantalum-nitrogen the final gas concentration down to which degassing is theoretically possible is determined by the partial pressures of the residual gases in the vacuum apparatus and not by the metal evaporation. The results of investigations by other workers of the degassing of vanadium-oxygen and vanadium-nitrogen melts are discussed and compared with the results of this work. (auth)

41606 (SC-DC-69-1954) SIMPLE DIFFUSION ANALYSIS OF HELIUM RELEASE EXPERIMENTS. Stark, Walter A. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 26p. (CONF-690809-1). Dep. CFSTI.

From PuO_2 Helium Release Information Meeting, Germantown, Md.

Using a simple model, diffusion coefficient for helium gas in PuO_2 plasma-torch fired (PTF) microspheres have been extracted from helium release measurement data. The release mechanism is assumed to be simple diffusion in homogeneous spheres of a single size. The diffusion coefficients obtained show a temperature dependence that can be approximately fit with a two-term diffusion coefficient; however, the data show much scatter. Certain features of the release behavior indicate that the diffusion mechanism assumed here is being modified by other factors. Some speculations are offered as to the nature of these complicating factors. (auth)

41607 (UCRL-19004) FRACTURE TOUGHNESS OF PRECIPITATION HARDENING ALUMINUM ALLOYS. Porter, David Eugene (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 135p. Dep. CFSTI.

Thesis.

The mechanical properties of five high purity aluminum-zinc alloys (7 to 50% Zn) and four high purity aluminum-silver alloys (5 to 30% Ag) were investigated. Emphasis was placed on intergranular fracture. The properties were correlated with the microstructure and fractographic observations. There were two basic intergranular fracture processes, a slow and a fast-crack growth process. Slow-crack growth occurred by microvoid coalescence, leaving a dull fracture surface. Fast-crack growth leaves a bright featureless surface. Of the alloys studied, only the aluminum-zinc alloys with 25% zinc or more in the maximum strength condition were found to fracture by a fast-crack growth process. Fast-crack growth was generally preceded by slow-crack growth. The latter process took place at lower stress intensity levels and if allowed to continue under a constant load it would lead to failure. Crack growth would continue under a constant load that was sufficient for initiation of the process as there was no mechanism to blunt the crack. The calculated value of the stress intensity factor for slow-crack growth, based on the energy dissipated in the plastic zone, was consistent with the measured value. Stress-wave emission records for the slow-crack growth process indicated that the process was discontinuous with the crack jumping along the grain-boundary from one grain-boundary node to another. (auth)

41608 TITANIUM-BASE ALLOYS. Cox, Howard D.; Rosenberg, Harry W. (to Titanium Metals Corp. of America). U. S. Patent 3,457,068. Filed Feb. 8, 1966.

A titanium base alloy consisting essentially of about 1.5 to 3% Al, 1 to 4% Sn, the percent of Al plus Sn present not to exceed 3.5%, 2 to 4% Mo, up to 5% Zr, up to 0.5% Be, up to 0.4% in total amount of C, O_2 and N_2, balance titanium. The titanium alloy exhibits good weldability and resistance to stress corrosion in the presence of a halide or halogen environment. (Offic. Gaz.)

41609 METALLURGIYA PLUTONIYA. (Metallurgy of Plutonium). Vol'skii, A. N.; Sterlin, Ya. M. Moscow, Izdatel'stvo Nauka, 1967. 252p.

Information is given on the: physicochemical properties of Pu and its compounds and alloys; preparation of pure Pu compounds; metallurgical treatment of metallic Pu; treatment of reactor irradiated U as a means of Pu extraction; Pu refining and waste processing; Pu micrometallurgy; preparation of anhydrous plutonium fluorides; and reduction of halide salts. Problems involving safety and biological effects of Pu, dosimetric control, and detectors are briefly reviewed. (395 references). (R.V.J.)

41610 THERMAL EXPANSIVITIES, THERMAL CONDUCTIVITIES, AND DENSITIES OF VANADIUM, TITANIUM, CHROMIUM, AND SOME VANADIUM-BASE ALLOYS (A COMPARISON WITH AUSTENITIC STAINLESS STEEL). Yaggee, F. L.; Gilbert, E. R.; Styles, J. W. (Argonne National Lab., Ill.). J. Less-Common Metals, 19: 39-51(Sept. 1969).

Computer-fitted polynomial expressions are presented that define the linear thermal–expansion behavior of vanadium, titanium, chromium, certain V–Ti and V–Ti–Cr alloys, and AISI Types 304 and 316 stainless steels between 0 and 1000°C. The mean expansion coefficients for the vanadium–base alloys differ only slightly from those for unalloyed vanadium (plus or minus 6%), and are 65% to 80% lower than the mean expansion coefficients for the austenitic stainless steels. Densities of the vanadium–base alloys and the austenitic stainless steels were determined at 25°C by liquid displacement. The V–Ti alloys show a non-linear decrease in density with increasing titanium for titanium contents greater than 30 wt %. The V–Ti–Cr alloys also exhibit a non-linear change in density for compositions containing greater than 15 wt % titanium and greater than 5 wt % chromium. A comparison of the mechanical and thermal properties of two vanadium-base alloys and two austenitic stainless steels was made to determine their relative usefulness as reactor fuel jackets for service between 500 and 700°C. This comparison shows that vanadium alloy fuel jackets would be subjected to only one-third the thermal stresses generated in austenitic stainless steel jackets during reactor excursions between 500 and 700°C under conditions where the fuel is not in intimate contact with the jacket. This difference in thermal stresses in the two jacket materials is the result of the 37% higher tensile strength, 40% higher thermal conductivity, and 70% lower thermal expansivity exhibited by the vanadium alloys as compared with austenitic stainless steel. (auth)

41611 DIFFUSION OF COBALT, SILVER, AND GOLD IN PRASEODYMIUM. Dariel, M. P. (Nuclear Research Centre, Negev, Israel); Erez, G.; Schmidt, G. M. J. J. Appl. Phys., 40: 2746-50(June 1969).

The thin-layer lathe-sectioning technique was used to measure the solute diffusivities of cobalt, silver, and gold in dhcp and bcc praseodymium. The diffusivities in the bcc phase can be described $D_{Ag} = 3.2 \times 10^{-2} \exp(-21\,500/RT)$ and $D_{Au} = 3.3 \times 10^{-2} \exp(-20\,100/RT)$ cm²/sec. In polycrystalline samples the average of the diffusivities along the two axes of dhcp praseodymium can be expressed by $D_{Co} = 4.7 \times 10^{-2} \exp (-16\ 400/RT)$, $D_{Ag} = 1.4 \times 10^{-1} \exp (-25\ 400/RT)$, and $D_{Au} = 4.3 \times 10^{-2} \exp (-19\ 700/RT$, cm^2/sec. These diffusivities are substantially higher than the self-diffusion coefficients of praseodymium. The change in the crystalline structure of the matrix affects only slightly the solute diffusivities, contrary to its effect on the self-diffusion coefficients. The remarkable similarity of these results with those concerning the solute diffusion of noble metals in Group III-B and IV-B metals, suggests that the same diffusion mechanism by interstitials operates in both cases. (auth)

41612 HAFNIUM. I. MICROSTRUCTURE. Vahldiek, F. W. (Air Force Materials Lab., Dayton, Ohio). J. Less-Common Metals, 19: 83-92(Oct. 1969).

The dislocation density of hafnium was reduced from 10^9 to 10^7 cm^{-2} by multiple electron beam melting. A decrease in oxygen content from 0.210 to 0.030% was achieved by three electron beam melting passes. The unpinned dislocation velocity was found to increase from 2.5×10^{-5} to 6×10^{-3} cm sec^{-1} with increasing temperature (80 to 600°C). Electron and x-ray diffraction studies showed only the alpha hexagonal phase of hafnium present in the specimens. Thermal stresses in hafnium produced prismatic slip of the $\{10\bar{1}0\}$ $\langle 11\bar{2}0\rangle$ type. Mechanical twins of the $\{10\bar{1}2\}$ $\langle 10\bar{1}1\rangle$ type were also found in thin films of hafnium. Stacking faults were observed in the as-received, oxygen-rich hafnium samples. (auth)

41613 ADVANCED TECHNIQUES FOR MATERIAL INVESTIGATION AND FABRICATION. 14th National Symposium and Exhibit, Cocoa Beach, Florida, November 5, 6, 7, 1968. Science of Advanced Materials and Process Engineering Proceedings. Volume 14. Society of Aerospace Material and Process Engineers, 1968. 810p. (CONF-681126). North Hollywood, Calif., Western Periodicals Company.

Seventy-nine articles are included; separate abstracts were prepared for 13. The remaining 65 articles contain information on: microscopy; special test techniques; spectroscopy and thermal analysis; composites; plastic structures; electroplating and chemical milling; microcircuit fabrication technology; diffusion bonding and diffusion welding; microjoining technology; machining of composites and refractories; printed circuits and multilayer board fabrication; stretch forming spin forming ablatives and high temperatures; adhesives and bonding; and high-energy forming. (P.C.H.)

For abstracts of individual papers see: 40731, 41551, 41577–41579, 41614–41618, 41715, 41716, and 41731.

41614 ELECTRON FRACTOGRAPHIC STUDY OF FATIGUE CRACKS IN WROUGHT BERYLLIUM SHEET. Russo, M.; Krieg, J. F.; Tourkakis, H. C. (McDonnell Aircraft Co., St. Louis). Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-5-3(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

An electron fractographic study was conducted to investigate fatigue cracks in wrought beryllium sheet. The fatigue cracks were generated from a centrally placed elox slot in 0.040-inch thick panels by subjecting the specimen, at room temperature, to cyclic loads at a stress ratio of 0.2. The maximum gross stress (15 to 30 ksi) was varied during the fatigue test program and was changed at different crack lengths. The fatigue crack portion of the fracture surface exhibited both transgranular and intergranular modes of fracture. Fatigue striations were observed only in transgranular areas of fracture. The fracture surface resulting from overload exhibited only cleavage features. (auth)

41615 COMPATIBILITY OF REFRACTORY METALS, PRECIOUS METALS, AND SEVERAL COATINGS. Benn, E. (Atomics International, Canoga Park, Calif.). Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-5-4(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

Compatibility tests were performed on coupon stacks of platinum- and tantalum-based alloys. Several of the platinum-10% rhodium coupons were coated with plasma sprayed iron titanate and some T-111 discs were coated with CVD alpha alumina. The tests were conducted at a pressure of 10^{-8} torr and at temperatures ranging from 2000 to 2500°F. The duration of the tests ranged from 10 to 2200 hours. The compatibility of the materials (including ceramic coatings) was evaluated both metallographically and by the microprobe. The metallographic work involved differential polishing and etching techniques to reveal all of the complex structures. The microprobe investigations yielded diffusion gradient and vapor transport data. (auth)

41616 COATED REFRACTORY ALLOY FOR REUSABLE RE-ENTRY STRUCTURES. Witt, Robert H. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-5-5(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

A materials effort was made in support of the design, fabrication, and testing of a full-scale control surface test article. Materials testing data are reported for oxidation protection, as well as the results of supporting test work necessary to make the control surface fabrication and test possible. The alloy selected was Ta–10W, after evaluating strength-to-density data in comparison with T-222 tantalum. Ta–10W was considered most attractive for use in structures made to operate near 3000°F mainly on the basis of cost, availability, and fabricability plus adequate mechanical properties. Ta–10W from three suppliers in the range of 0.010 to 0.080 inch thick was evaluated. It was found that the R512C coating on Ta–10W provides a ductile system exhibiting excellent ductility between room temperature and 1800°F. Arc jet test results are also included for the R512C and R515 (Hf-Ta) coatings on Ta–10W. Faying surface testing of R512C coated Ta–10W led to solving problems with mechanical fastener and thermocouple installation techniques. Quality control techniques have been developed for assuring adequate coating thickness on rivet heads and tails. A thermocouple installation technique has been developed which makes possible cyclic exposures of these installations in air up to 3000°F and vacuum (5×10^{-5} torr) exposures to 2600°F for one hour. (auth)

41617 HIGH-TEMPERATURE MAGNETIC TEST TECHNIQUES AND ANALYSES. Pavlovic, D. M. (Westinghouse Electric Corp., Lima, Ohio); Towner, R. J.; Clark, J. J.; Lindberg, R. A. Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-2-6(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

High-temperature magnetic test techniques were developed and applied to the measurement of structure-sensitive hysteresis properties. The concurrent changes in magnetic properties were analyzed to indicate and follow changes in matrix composition and carbide coarsening in H-11 tool steel, and austenite reversion and precipitate coarsening in maraging steel at temperatures up to 800 to 1100°F. Coercive force versus temperature measurements up to 1600 to 1900°F were applied to the analysis of structural changes in dispersion-strengthened, fiber-reinforced, and eutectic-strengthened metal-matrix composites. Examples of application of this technique are given for detection and analysis of the hexagonal to face centered cubic cobalt transformation, precipitation from a cobalt solid solution, and thermal stabilization of the matrix structure in dispersion-strengthened cobalt and iron +27 wt % cobalt by thermomechanical treatments. (auth)

41618 CHEMICAL COMPATIBILITY BETWEEN CERAMIC WHISKERS AND METALLIC MATRICE MATERIALS. Stuadhammer, Karl P.; Toy, Albert; Kirkpatrick, Milton E. (TRW Systems, Redondo Beach, Calif.). Sci. Advan. Mater. Process Eng. Proc., 14: Paper II-4A-1(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

The establishment of compatible whisker reinforced metal matrix composite systems for the purpose of developing highly efficient structural materials was studied. Many whiskers are thermodynamically unstable with respect to various metallic matrices during composite formation, and sometimes require protective coatings to reduce interfacial reactivity and maintain fiber integrity. Composite systems investigated included uncoated and coated β-SiC whiskers in a titanium matrix. Examination of fiber-matrix reactions was made by optical and electron metallography, x-ray diffraction, and electron microprobe analysis. Results indicated that titanium is highly reactive with β-SiC. A coating of Ag, was found to inhibit or minimize fiber-matrix interaction between the whisker/titanium systems. (auth)

41619 SELF-DIFFUSION OF COLUMBIUM. Pelleg, Joshua; Lindberg, G. M. (National Research Council of Canada, Ottawa). Trans. Met. Soc. AIME, 245: 1654-5(July 1969).

Details are given of recalculations of diffusion data showing that apparent discrepancies in recorded data by various laboratories are within an acceptable limit. (J.R.D.)

41620 GRAIN-BOUNDARY SLIDING AND CAVITY GROWTH DURING THE HIGH-TEMPERATURE FATIGUE OF MAGNOX A180. Evans, H. E.; Skelton, R. P. (Central Electricity Generating Board, Berkeley, Eng.). Metal Sci. J., 3: 152-5(July 1969).

The effect of grain size on the high-temperature fatigue properties of an Mg-0.8% Al alloy was studied. A reduction in rupture life occurred when the grain size exceeded the specimen thickness. It is shown that this effect is related to an increase in the initial plastic strain amplitude, caused by an increase in the rate of grain-boundary sliding. It is also established that this deformation mode controls cavity growth, and that failure occurs at a critical mean value of the sliding displacement, independent of applied stress and structure. (auth) (UK)

41621 HARDNESS OF NIOBIUM–NITROGEN AND NIOBIUM–OXYGEN ALLOYS. Szkopiak, Z. C. (Univ. of Surrey, Eng.). J. Less-Common Metals, 19: 93-103(Oct. 1969).

Solution hardening of niobium by nitrogen and oxygen has been studied by the measurement of hardness at room temperature. Three-stage hardening has been observed. In Stage I the hardening obeys the $\frac{1}{2}$ power law of concentration, while in Stages II and III, the power law of one. It has been observed that Stage II overlaps about 50% of Stage I. It has been confirmed that nitrogen is more effective than oxygen in solution hardening, and that grain size has a comparatively small effect on the hardness of electron-beam-refined niobium containing nitrogen and oxygen in solid solution. (auth)

41622 LARGE CREEP DUCTILITY OF ALPHA PLUTONIUM. Nelson, R. D.; Bowman, F. E. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Trans. Met. Soc. AIME, 245: 1656-8(July 1969).

Abnormally large elongation was observed in α Pu. It is suggested that grain boundary sliding together with diffusion controlled processes which satisfied the necessary compatibility among the grains played important roles. It is noted that the ductility of normally brittle α Pu should increase when Pu can be produced having an average grain size of about 1 μ. (J.R.D.)

41623 THERMAL EXPANSION OF NIOBIUM, MOLYBDENUM, AND THEIR ALLOYS AT LOW TEMPERATURES. Lebedev, V. P.; Mamalui, A. A.; Pervakov, V. A.; Petrenko, N. S.; Popov, V. P.; Khotkevich, V. I. (Kharkov State Univ.). Ukr. Fiz. Zh., 14: 746-50(May 1969). (In Russian).

The temperature dependence of the coefficient of thermal expansion, α, of niobium, molybdenum, and the niobium base alloy (Nb + (3.8 to 5.2)% Mo + 0.2% Ta, other impurities less than 0.2%) was obtained in the temperature range of 4.2 to 300°K. The value of α for niobium and molybdenum was in good agreement with literature data. α of the alloy was just below the α for niobium over the whole temperature range. The result is probably associated with deformation of phonon spectrum in a low temperature range, but at higher temperatures—with the difference of anharmonism in thermal oscillations of niobium and the alloy. (auth)

41624 ANOMALOUS DECREASE IN YOUNG'S MODULUS OF γ-CERIUM ALLOYS AT LOW TEMPERATURES. Clinard, Frank W. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys., 40: 3067-9(June 1969).

Detailed modulus measurements are reported on cerium at ambient pressure as a function of temperature. Three cerium-rich compositions were studied: cerium stock used in making alloys; cerium–1.2 at. % magnesium alloy; and cerium–4.4 at. % magnesium alloy. Some results obtained were: (1) that on cooling near room temperature, the resonant frequency of the γ phase stays approximately constant or rises slightly; (2) on further cooling, the resonant frequency shows an anomalous decrease; and (3) at the lowest temperatures, the beginning of the $\gamma \rightarrow \alpha$ transformation is indicated by a sharp rise in resonant frequency. The largest anomaly was observed for the Ce–4.4 at. % Mg alloy. This sample showed a total decrease in Young's modulus of 54.1% (not considering dimensional changes) as contrasted with 6.7% for the unalloyed cerium and 10.0% for the Ce–1.2 at. % Mg alloy. (D.H.M.)

41625 OPTICAL CONSTANTS OF Ti–TiN–TiC AND Zr–ZrN–ZrC. Knosp, Helmut; Gerold, Volkmar (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 60: 627-35(Aug. 1969). (In German).

The optical constants of hot-pressed specimens within the homogeneity region of the refractory compounds Ti–TiN–TiC and Zr–ZrN–ZrC were measured in the spectral range between 275 and 750 nm and discussed with respect to the dispersion ϵ_1 and the absorption ϵ_2. The effective numbers of free electrons for the nitrides and the nitride-rich compounds were calculated from the dispersion with assist of the classical theory. The effective number of free electrons was reduced for a valence electron concentration (VEC) between 9 and 8 valence electrons. For a VEC less than 8 the number of free electrons remained constant. It was evident that maximum stability occurs for a VEC of 8 valence electrons. The absorption corresponded in the visible region only for the approximately stoichiometric nitrides, especially for ZrN, with the electron gas theory. Maximums of the energy loss function confirmed this result. Additional absorption bands (bound states) arose if nitrogen was replaced by carbon and with increasing vacancies of non-metal. (auth)

41626 TUNGSTEN NEWS. JUNE 1969. Tungsten News, 1-18(June 1969).

Tungsten is used for fibers or filaments in composites because of its high stiffness, high hot strength, resistance to attack by metals with which it may be combined, and its ready availability in fine wire form. Recent advances in sintering, casting, rolling, machining, brazing, and welding of tungsten metal are discussed. New methods in chemical vapor deposition have been made. Experiments testing the physical properties of mono- and polycrystalline W have been performed resulting in new data. Reference is given to development of a gasoline-fired thermionic power supply utilizing W. Recent papers on surface phenomena are listed. Toughness, wear resistance, adherence, deformities, crystal studies, and milling properties of WC are updated. Tungsten-base alloy studies include W–Re, W–UO_2, W–Cu, W–Ni–Fe, W–Mo, and tungsten with hafnia or thoria additions. The W–Zr phase diagram has been studied and a field-emission microscopy investigation carried out on alloys with 1% Gd_2O_3. New data on W as an alloying element and data on W in superalloys are given. W applications in the steel and tool industries are listed. Fabrication techniques and properties of tungsten compounds are summarized. (J.C.W.)

41627 A STUDY OF SOME PROPERTIES OF NIOBIUM–MOLYBDENUM ALLOYS. Chudarev, L. F. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 28, 20-8 (1968). (In Russian).

A study was made of the effect of Ti, Zr, and B on the properties of Nb–Mo alloys. Solid solutions form at certain concentrations of alloying additions in the Nb–Mo–Ti and Nb–Mo–Zr systems, while there was a eutectic in the Nb–Mo–B system. The effect was shown of the alloying element content on hardness. Hot hardness and torsion tests were used to show the effectiveness of small additions of Ti, Zr, and B on the creep rate. The differential method was used to study the basic parameters of creep thus allowing the activation energy of this process to be determined for complex alloys. (Referativnyi Zh.)

41628 CREEP RATCHETTING IN NUCLEAR REACTOR FUEL ELEMENTS. Hibbeler, Russell Charles. Evanston, Ill., Northwestern Univ., 1968. 152p.
Thesis.

The cladding of a sealed reactor fuel element, under the influence of internal pressure and a sufficiently high temperature gradient, may deform due to internal stress relaxation caused by creep. When the temperature gradient across the clad wall is cycled due to power change requirements of the reactor, the creep strains developed in the cladding may cause ratchetting or progressive growth of the fuel element in both the radial and axial directions. Assuming elastic stress interaction, a simple uniaxial stress model of the fuel element is developed, and the equations which determine the solution of the problem are presented. The flexibility of the analysis allows the engineer to include the effects of an arbitrary temperature cycle time and temperature dependence of material properties. Furthermore, the variation of external loading caused by fuel swelling and fission gas release is taken into account. A linear creep law having the form $\dot{\epsilon} = K(\sigma - \sigma_0)$ is used to describe the behavior of the material during the cycle time at each temperature. A method for using this law when the material has an arbitrary creep law variation is presented, and a simple numerical example is worked in order to illustrate the use of this method when the creep strain rate is related to stress by a simple power law. It is found that the accuracy of the method improves as the external loading becomes larger than the thermal stress variation. A study is made to show what effect the material properties and loading have on influencing the ratchetting and creep acceleration behavior of the model. The accuracy of the results when applied to reactor fuel elements is then discussed. (Diss. Abstr.)

41629 STEEL CASTINGS FOR NUCLEAR POWER PLANT. Lueling, Heinrich; Gysel, Walter. Giesserei, 55: 331-45(June 6, 1968). (In German).

The economic importance, quality requirements and potential applications (in primary and secondary circulation systems of a nuclear power plant) of steel castings are reviewed. Various steels potentially of use and some applications are described. (tr-auth)

41630 PROPERTIES OF SOLID SOLUTIONS OF INTERSTITIAL IMPURITY ATOMS IN VANADIUM, NIOBIUM, AND TANTALUM. Schlaet, F.; Koethe, A.; Rexer, E. (Institut fuer Metallphysik und Reinstmetalle, Dresden). pp 240-53 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The systems formed by the metals of the V subgroup with hydrogen, oxygen, nitrogen, and carbon below the solubility limits are reviewed. The processes occurring in the degassing, the diffusion of the interstitial impurity atoms, and their effects on the physical properties of the metals are also considered. Special attention was given to recrystallization due to cold working between stages of heat treatment. (tr-auth)

41631 NEW INVESTIGATIONS ON THE ORIGIN OF BRITTLE FRACTURE IN SPACE-CENTERED-CUBIC METALS. Schlaubitz, K.; Mueller, D.; Rexer, E. (Institut fuer Metallphysik und Reinstmetalle, Dresden). pp 254-78 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

A review is presented on the experimental studies on brittle fracture in cubic body-centered metals done since 1963. Yield point and brittle fracture stress for the metals Cr, Mo, and W are discussed. Seed formation processes in the fracture are considered for Fe, Cr, Mo, and W. The review indicates that hypothetical models of brittle fracture must be expanded by experimental studies of actual construction materials with respect to inhomogeneities of various types. (100 references.) (J.S.R.)

41632 RELATIONSHIP BETWEEN STRUCTURAL STATES AND PROPERTIES OF MOLYBDENUM AND TUNGSTEN. Ringpfeil, H.; Krumphold, R. (Forschungsinstitut fuer Metallische Spezialwerkstoffe, Dresden). pp 279-94 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

Partial results obtained on the study of the relation between structural states and properties of Mo and W are reported. The conditions for brittle fracture are summarized. The ductile/brittle transition of Mo, as determined in bend tests, is described. The workability of Mo was evaluated by bending tests. Embrittlement in Mo and W was caused by precipitation at the grain boundary surface. The composition of the precipitation phase was determined. (J.S.R.)

41633 INVESTIGATIONS ON THE ORIGIN AND DETECTION OF CLEAVAGE PHENOMENA IN TUNGSTEN WIRE. Stolarz, S. (Institut fuer NE-Metalle, Gliwice, Poland); Jesionek, B.; Kostkovskii A. pp 295-305 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

Studies were made on the detection of cleavage phenomena in W wires using the method of torsion under stress and the measurement of the modulus of elasticity under stress. The results obtained were compared with those obtained with the fault testing device of Foerster. The effects of forging, annealing, and drawing of rods on the cleavage of W wires were also studied. The results showed that cleavage can be caused by impurities in the initial material and by variations in the technological parameters during processing of the powder to the wire. (J.S.R.)

41634 ABSORPTION OF NITROGEN, OXYGEN, HYDROGEN, AND CARBON FROM TECHNICAL HELIUM OR SODIUM IN HIGH-MELTING METALS. Agapova, N. P.; Borodic, W. D.; Poltuchovskii, A. G.; Taritina, M. I.; Chaikovskii, A. A. (Inst. for Atomic Energy, Moscow). pp 186-91 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

Studies were made on the absorption of oxygen, nitrogen, and hydrogen impurities from technical helium and sodium by Ti, Zr, V, Nb, Ta, Mo, and W at temperatures from 900 to 1100°C. The results showed that the absorption capacity of the metal is dependent on its place in the periodic system. The plasticity of the elements of Group VI B was not altered because of their low gas uptake, whereas the elements of Group IV B were completely embrittled. By addition of alloying elements from Groups IV B, V B, and VI B (about 8 to 10 at.%), the absorption capacity of Nb was altered. Additions of Ti, Zr, or V, which are strongly absorbing metals, increased and additions of W, Mo, or Ta reduced the gas absorption of Nb. Under the same research conditions Ta, Nb, and Nb alloys absorbed more oxygen from He than from liquid Na. (tr-auth)

41635 DEVELOPMENT OF CORROSION-RESISTANT ZIRCONIUM-NIOBIUM ALLOYS WITH HIGH STRENGTH FOR WATER-COOLED NUCLEAR REACTORS. Ruckdeschel, W.; Wincierz, P. (Metallgesellschaft AG., Frankfurt am Main). pp 126-58 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

Work done since 1960 on the development of corrosion-resistant Zr–Nb alloys is summarized. The mechanical and corrosion-resistant properties used in the evaluation of the ternary alloy Zr–3 Nb–1 Sn are described. The effects of structure, oxygen content, heat treatment, and neutron irradiation on the properties of binary and ternary Zr–Nb alloys are indicated. Problems connected with the production of semifinished alloys are discussed, and alloys developed for expanded temperature range are considered. (59 references) (J.S.R.)

41636 INFLUENCE OF THE OXYGEN CONTENT ON THE PROPERTIES OF Zr–Nb ALLOYS. Bohmeier, H.; Juknat, R. (Forschungsinstitut fuer Nichteisenmetalle, Freiberg, Ger.). pp 159-74 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

The impurities present in the electron beam melting of scraps of Zr–1 Nb and Zr–2.5 Nb alloys of different origin were determined and the gas content was measured. Oxygen was the principal impurity. Working of the scrap melts is described and the effects of the degree of working and the oxygen content on the hardness were determined. The thermal expansion, elasticity modulus, tensile strength, time modifications, impact strength, and the Poisson constant were measured for the worked samples. The results showed that Zr–1 Nb and Zr–2.5 Nb alloys adulterated with scrap can be used in reactors. (J.S.R.)

41637 EIGENSCHAFTEN UND ANWENDUNG HOCHSCHMELZENDER UND REAKTIVER METALLE. VORTRAEGE UND DISKUSSIONEN ZUM KOLLOQUIUM VOM 15. BIS 18. FEBRUAR 1967 IN DRESDEN. (Properties and Uses of High-Melting and Reactive Metals. Contributions and Discussions at Conference, February 15–18, 1967 in Dresden). Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. 328p. 38,50 M. (CONF-670222).

The 22 papers presented at the Dresden Conference are compiled and presented together with the discussions following each paper. A separate abstract was prepared for 17 papers. The remaining 5 papers were not within the scope of NSA. (J.S.R.)

For abstracts of individual papers see: 41553–41555, 41586–41590, 41630–41636, 41638, and 41672.

41638 SOME REMARK ON THE SCIENTIFIC-TECHNICAL AND INDUSTRIAL DEVELOPMENTS IN THE FIELD OF REACTIVE AND HIGH-MELTING METALS. Lange, W. (Forschungsinstitut fuer Nichteisenmetalle, Freiberg, Ger.). pp 7-15 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

Some of the most significant results from recent studies of reactive and high-melting metals are briefly indicated. These include the solubility of oxygen, hydrogen, nitrogen, and carbon in these metals, the temperature dependence of the solubility, and factors affecting the embrittlement of the metals. The industrial production of these metals and their alloys is also discussed. (J.S.R.)

41639 THERMODYNAMIC BEHAVIOR OF DILUTE SOLUTIONS OF HYDROGEN AND DEUTERIUM IN TITANIUM AND ZIRCONIUM. McQuillan, A. D.; Wallbank, A. D. (Univ. of Birmingham, Eng.). J. Chem. Phys., 51: 1026-31(Aug. 1, 1969).

An investigation has been made of the partial free energy of very dilute solutions of hydrogen and deuterium in the high-temperature, body-centered cubic forms of titanium and zirconium. Anomalous behavior is found which manifests itself as a departure from Sieverts' law. Analysis of the results indicates that there is a strongly marked minimum in the partial enthalpy at hydrogen and deuterium concentrations of about 1 at.% in both metals. This may be associated with a departure from complete randomness in the distribution of interstitial atoms in the solution. (auth)

41640 THE EFFECT OF CARBON ON THE MECHANICAL PROPERTIES AND STRUCTURE OF MOLYBDENUM PREPARED BY ELECTRON-BEAM MELTING. Movchan, B. A. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 28, 91-9(1968). (In Russian).

A study was made of the effect of C content on the mechanical properties of Mo. The ductility of cast, forged, and recrystallized alloys is increased by C additions of 0.06 to 0.15%. The O concentration of the alloys was independent of the C content. (Referativnyi Zh.)

41641 A NEW CAST ALLOY IN THE SPACE INDUSTRY: HIGH DAMPING CAPACITY MAGNESIUM–ZIRCONIUM. Plenard, Elisabeth; Mena, Andre. Fonderie, No. 274, 11-27(Jan. 1969). (In French).

A new alloy, Mg–0.6% Zr, is being used for castings in the space industry because of its very high damping capacity. This damping capacity is of the same order as that shown by plastic materials and is almost the highest shown by a metal. This characteristic, together with the low density of the alloy, points to its application in systems where vibrations must be kept to a minimum. In order to define the optimum conditions for use of the alloy the effects of stress, pre-stressing, and aging after pre-stressing on the damping characteristics were examined. The damping properties of the alloy are thought to be caused by a twinning-detwinning mechanism; the effects of the parameters studied fits this interpretation. (Metals Abstr.)

41642 RECOVERY OF COLD-WORKED MOLYBDENUM. Stals, L.; Nihoul, J. (SCK–CEN, Mol, Belg.). Physica, 42: 165-78(Apr. 21, 1969).

Molybdenum wires of 0.05 mm diameter were drawn at room temperature from an electron beam refined rod. These wires were subsequently subjected to isochronal and isothermal annealing treatments in a temperature range from 300 to 1200°K. The electrical resistivity is shown to decrease in four stages: stage III (300–500°K), stage IV (500–700°K), stage V (700–900°K), and stage VI (900–1200°K). These stages are associated with activation energies of 1.3 eV, 2.5 eV, and 3.7 eV, respectively. The kinetics of the pronounced stage III recovery are compatible with a diffusion-controlled bimolecular reaction. It is proposed that stage III is mainly due to free migration of interstitials to vacancies, stage IV to free migration of remaining vacancies, stage V to dislocation rearrangements and annealing, and stage VI to recrystallization. (auth)

41643 THE DIFFUSION AND SOLUBILITY OF GOLD IN SODIUM. Barr, L. W.; Mundy, J. N.; Smith, F. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 20: 389-98(Aug. 1969).

The diffusion coefficient and solubility of gold in sodium were measured between 0°C and 77°C. The diffusion is described by the equation: $D = (3.34 \pm 1.0) \times 10^{-4} \exp(-2.21 \pm 0.2/RT)$ cm^2 sec^{-1} and the solubility by the equation: $S = (5.4 \pm 6.5) \times 10^4 \exp(-11.2 \pm 0.7/RT)$ at.%, where the activation energies are in kcal mol^{-1}. Reasons are given for believing that diffusion is by interstitial defects, although diffusion by tightly bound impurity-vacancy pairs cannot be excluded. Unusual features of the gold concentration profile in specimens quenched to a low temperature before sectioning, notably an inverted slope immediately beneath the specimen surface and a low gold concentration "tail" extending deep into the crystal, are shown to be due to the high diffusion rate and low solubility of gold in sodium. (auth) (UK)

41644 CANNING MATERIALS FOR HEAVY WATER REACTORS. Edstroem, J. O.; Lagerberg, G. (Sandvik Steel Works, Sweden). Bull. Belgicatom, 14: No. 1, 12-14; 16-20(May-June 1969).

Zirconium alloys, austenitic stainless steels, and nickel alloys are the canning materials used in water cooled power reactors. The advantages and limitations of these materials are reviewed. (auth)

41645 AGEING, REVERSION, AND REAGEING OF COPPER–BERYLLIUM ALLOYS. Mishima, Yoshitsugu; Okubo, Tadatsune; Shiromizu, Ryusuke (Tokyo Univ.). Trans. Jap. Inst. Metals, 10: 73-80(Mar. 1969).

Age-hardening of some high purity Cu–Be binary alloys has been studied and the hardening curves were classified into three distinct types. As the low temperature aging process can be clearly distinguished from the high temperature aging process in such binary alloys, two curves were obtained corresponding to the respective processes. Complete reversion of hardness was found to occur if the hardening process prior to the reversion treatment remained within the zone formation stage. The reversion temperature corresponded to the lower temperature limit, above which the purely high temperature aging occurred. This occurrence of reversion was confirmed by means of transmission electron microscopy and a selected-area diffraction technique. The reversion temperature of the Guinier–Preston zone increased with increase in solute concentration (430 to 450°C for 1.91 wt % Be and, 330 to 380°C for 1.64 wt % Be alloy). Reaging after reversion occurred at a much slower rate within the zone formation stage because of the remarkable decrease in the number of quenched-in vacancies, but the reduction in rate was found to be much less in the stage of high temperature aging. The effects of Fe, Al, Si, and Co have also been studied. Among these, Co was found to be most effective in retarding the zone formation. This seems to be the cause of the difference between the aging behaviors of those binary alloys and commercial beryllium–copper. (auth)

41646 THERMODYNAMICS OF THE SOLUBILITY AND PERMEATION OF HYDROGEN IN METALS AT HIGH TEMPERATURE AND LOW PRESSURE. Shupe, D. S.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 51: 1620-5(Aug. 15, 1969).

The solubility and permeation of hydrogen in metals are analyzed on the basis of classical thermodynamics plus a minimum of kinetic theory. Expressions are derived for x, the number of H atoms absorbed per solid atom, and J, the permeation rate, in the limiting cases of continuum and free-molecule flow. For most conditions of temperature (T) and total pressure ($p_t = p_H + p_{H_2}$), the expressions reduce to the familiar equations for solubility and permeation, i.e., a curve for constant p_t appears as a straight line on Arrhenius plots of log x vs 1/T and of log J vs 1/T. However, for extreme conditions of high temperature and low pressure, the expressions predict that a curve of constant p_t will become increasingly nonlinear as T increases, and it may even pass through a maximum when T becomes sufficiently high to produce almost complete dissociation of the gaseous H_2. Also, under certain conditions neither x nor J is proportional to the square root of the total pressure. The analysis provides a simple explanation of existing experimental data on the solubility and permeation of hydrogen in tungsten and in molybdenum at high temperature and low pressure. (auth)

41647 EFFECT OF MEAN STRESS ON LOW-CYCLE FATIGUE DEFORMATION BEHAVIOR. Yamanouchi, Hidekazu; Asada, Yasuhide (Mitsubishi Heavy Industries, Ltd., Nagasaki). Mitsubishi Juko Giho, 6: 439-46(July 1969). (In Japanese).

Load controlled push-pull and bending low-cycle fatigue tests were conducted on ASTM A 302 B steel under room and elevated temperatures in order to investigate the effect of mean stress on low-cycle fatigue deformation behavior. This phenomenon is considered to be an important factor in the design of nuclear reactor, steam turbine casings, and chemical equipment because these apparatuses operate under such stress-strain condition that cyclic stress or strain is superposed on stationary stress, and deformation of their structural members progresses in stationary stress direction by each stress repetition. This phenomenon is similar to the thermal stress ratchet phenomenon. It was found that low-cycle fatigue deformation can be evaluated by the increment of mean strain during one cycle of stress and strain repetition. Low-cycle fatigue deformation increases as mean stress and stress amplitude increase. Low-cycle fatigue deformation of push-pull type stress condition is 1.4 ~ 1.45 times larger than that of bending stress condition. It is concluded that low-cycle fatigue deformation is the same phenomenon as the thermal stress ratchet phenomenon. (auth) (NSA of Japan)

41648 NITROGEN DAMPING PEAKS OF IRON ALLOY CONTAINING WOLFRAM. Soeno, Ko; Tuchiya, Masatoshi (Hitachi, Ltd., Japan). Nippon Kinzoku Gakkaishi, 33: 786-90 (July 1969). (In Japanese).

The internal friction due to nitrogen in iron alloys containing less than 2.5 at.% W was measured at frequencies of about 0.5, 1.0, 5.0, and 500 cps, and two peaks were observed. From the peak shifts, activation energies were determined as 17.2 kcal/mol for low temperature peak and 19.1 kcal/mol for high temperature peak. The low temperature peak, which can be nearly described by a single relaxation time, is interpreted as jumps of nitrogen atoms in strained Fe–Fe interstices produced by the addition of W atoms. The origin of the high temperature peak is attributed to the stress-induced diffusion of nitrogen atoms in the vicinity of W atoms. However, the half-width of the high temperature peak is by far broader than that of a peak having a single relaxation time. The broadening is discussed and is explained by allowing the relaxation time to have an appropriate error-functional distribution. The precipitation of nitrides was also investigated by using an iron alloy containing 2.5 at.% W and 300 ppM nitrogen. No precipitation of nitride other than Fe_8N and Fe_4N was observed. (auth)

41649 TEMPERATURE EFFECTS IN DESORPTION BY ELECTRON IMPACT: MOLECULAR VIBRATIONS IN THE CHEMISORBED LAYER. Madey, Theodore E.; Yates, John T. Jr. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 51: 1264-5(Aug. 1, 1969).

Results of studies concerning the interaction of O_2 with polycrystalline W are discussed which indicate that the terminal state, designated β_1, is the only state which liberates positive ions on electron impact. Further investigation revealed that the β state arises from chemisorbed molecules rather than from tungsten oxide. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 41612, 41646, 41740, and 42497.

41650 (BNWL-tr-40) THERMODYNAMICS OF CARBON AND OXYGEN COMPOUNDS OF LIQUID SODIUM. Hofer, Gerhard. Translated by Diana L. Davis (Battelle-Northwest, Richland, Wash.), from Z. Metallk., 60: 457-60(May 1969). 7p. Dep. CFSTI.

The three-phase equilibria in the ternary system sodium-carbon-oxygen were determined at 25, 677, 687 and 760°C by thermodynamic analysis. The activities for carbon and oxygen were calculated for the three-phase regions bordering sodium. (auth)

41651 (CEA-R-3538) HYPERFINE COUPLING IN GADOLINIUM–PRASEODYMIUM ALLOYS BY SPECIFIC HEAT MEASUREMENTS. Michel, Jean-Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). July 1969. 105p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

The hyperfine coupling in gadolinium–praseodymium alloys was studied by specific heat measurements down to 0.3°K. The apparatus used to perform the measurements is described and theoretical considerations are discussed. The case of praseodymium which is an exception in the rare earth series, was studied thoroughly; the results obtained are included. (auth)

41652 (COO-588-16) TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM–NIOBIUM AND OTHER ALLOYS. Perkins, A. J.; Hehemann, R. F. (Case Western Reserve Univ., Cleveland, Ohio. Dept. of Metallurgy). July 31, 1969. Contract AT(11-1)-588. 47p. Dep. CFSTI.

A modulated structure of beta and omega is developed when Zr–Nb alloys are aged at appropriate temperatures. Omega particles are cubic in shape with $\{0\,0\,1\}_\beta$ faces and are aligned in $\langle 0\,0\,1\rangle_\beta$ directions. Both the particle shape and alignment is interpreted in terms of strain energy developed during the transformation. The athermal omega reaction results from an instability in the bcc phase and the diffuse streaking in x-ray and electron diffraction patterns that accompanies this reaction is attributed to diffuse scattering produced by the unstable normal mode. Similar transition states resulting from an inherent lattice instability occur in a number of systems and frequently precede classical martensitic transformations. The Ti–Ni system has been chosen as the prototype for these systems. Transmission microscopy has revealed dislocation arrays that develop in the transition state and apparently eventually evolve into interfaces involved in the martensitic transformation. The concept that shuffles of atomic position required in the martensitic transformation occur initially as a lattice instability in the parent phase appears to warrent further development. (auth)

41653 (INR-1037) INTERDIFFUSION IN THE U-PAR1/Al, Mg,Si/SYSTEM. Gabrycki, S.; Matyja, H. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 11p. (In Polish). Dep.

Diffusion layer-growth in the interdiffusion in U-PAR1/Al, Mg, Si/system has been investigated in the temperature range 533 to 863°K. The activation energy and the coefficient k_0 were determined. (auth)

41654 (LA-tr-69-17) RGa_3 COMPOUNDS IN RARE-EARTH METAL–GALLIUM SYSTEMS. Kripyakevich, P. I.; Markiv, V. Ya.; Dzyana, D. I. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Ukr. Fiz. Zh., 9: 908-10(1964). 4p. Dep. CFSTI.

Results of investigations to determine the occurrence of AlB_2-type compounds in Tm–Ga and Lu–Ga alloys are reported. Powder x-ray diffraction analysis was used. It was found that the x-ray diffraction patterns do not belong to Ga or compounds of the AlB_2 type. It appears that $TmGa_3$ and $LuGa_3$ are in equilibrium with compounds richer in rare earths than RGa_2. Results of investigations of other rare earths indicate that with decreasing atomic radius of the rare earth, the tendency to form RGa_2 compounds decreases and the tendency to form RGa_3 compounds increases. (J.R.D.)

41655 (Y-DA-2952) SCANNING ELECTRON MICROSCOPE FRACTOGRAPHY OF A URANIUM–7.5 WT. PERCENT NIOBIUM–2.5 WT. PERCENT ZIRCONIUM ALLOY. Bennett, R. K.; Winslow, F. R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 19, 1969. Contract W-7405-eng-26. 18p. (CONF-690810–2). Dep. CFSTI.

From 27th Annual Electron Microscopy Society of America, St. Paul, Minn.

Studies showed that the use of the scanning electron microscope for fractographic study instead of conventional replica techniques in the transmission electron microscope not only shortened the time necessary to obtain the data, but also furnished information concerning the deep cracks which might have been difficult to obtain or even lost using the replica technique. (auth)

41656 ELECTRON MICROPROBE EXAMINATION OF PLUTONIUM–ALUMINUM ALLOYS. Harvey, M. R.; Riefenberg, D. H.; Smith, C. J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Metallography, 2: 109-12(Mar. 1969).

In analysis of x ray spectra of Al–Pu alloys the Al K_α and the Pu M_α can be correlated by use of an empirical equation for binary systems. Data for Al K_α radiation are included which indicate a strong absorption effect not predicted by mass absorption data tabies, emphasizing the necessity for use of standards techniques for accurate analysis. (J.R.D.)

41657 PLUTONIUM–EUROPIUM SYSTEM. Wood, D. H.; Cramer, E. M. (Univ. of California, Livermore). J. Less-Common Metals, 19: 66-7(Sept. 1969).

Compositions of Pu and Eu were made and subjected to differential thermal analysis. Results of phase studies are summarized. (J.R.D.)

41658 ORIENTATION DETERMINATION FROM DODECAHEDRAL ETCH PITS. Loh, B. T. M. (Oak Ridge National Lab., Tenn.). Metallography, 2: 79-88(Mar. 1969).

A simple, rapid, and accurate method has been developed for determining the crystal face orientation of cubic metals from dodecahedral etch pits. The few procedures involved in the method include measuring the two diagonal ratios of a (four-sided) pit, looking up two angles which define the orientation of the crystal from graphs which plot their angles as a function of the diagonal ratios, and plotting the two angles as a stereographic projection. The method is restricted to those systems which allow four-sided pits to be formed from one family of planes. (auth)

41659 METASTABLE SOLUBILITY OF TUNGSTEN IN ALUMINUM. Tonejc, A.; Bonefacic, A. (Univ. of Zagreb). Trans. Met. Soc. AIME, 245: 1664(July 1969).

Data and information are presented to show that the metastable solubility of W in Al can be appreciably extended in Al-rich Al–W alloys. A method is described to obtain, by rapid quenching, Al-rich Al–W solid solutions in which the solubility of W is increased to about 0.95 at. %. This value is much greater than any similar value known up to now. (J.R.D.)

41660 PRECIPITATION PROCESSES IN A Mg–Th–Zr ALLOY. Mushovic, J. N.; Stoloff, N. S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Trans. Met. Soc. AIME, 245: 1449-56(July 1969).

Age hardening response of a Mg–Th–Zr alloy has been studied at temperatures in the range 60 to 450°C. Transmission microscopy revealed clustering of thorium atoms at low aging temperatures, supporting a previous report of GP zone formation. Peak strengthening, which is observed at 325°C, is due to the formation of a coherent, ordered, DO_{19} type superlattice structure, of probable composition Mg_3Th, as plates parallel to the matrix prism planes. These plates later reveal a Laves phase structure of composition Mg_2Th. The equilibrium Mg_4Th phase begins to precipitate in two different forms at an early stage, competitively with the Mg_2Th plates. (auth)

41661 THE LANTHANUM–RHODIUM SYSTEM. Singh, P. P.; Raman, A. (Louisiana State Univ., Baton Rouge). Trans. Met. Soc. AIME, 245: 1561-8(July 1969).

The constitution of the La–Rh system was studied by powder x-ray diffraction, metallographic, and differential thermal analysis techniques. An equilibrium diagram is presented. Eleven intermediate phases occur in the system and the crystal structural data for nine of them were determined. La_3Rh crystallizes in an orthorhombic structure of undetermined type, whose unit cell is obtained by doubling the "a_0" and "c_0" edges of an Fe_3C type unit cell. The other intermediate phases of the system are $La_4Rh_{\sim 3}$ (anti-Th_3P_4-type), LaRh(CrB-type), $LaRh_2$(l)($MgCu_2$-type), $LaRh_3$ (l)($CeNi_3$-type), $LaRh_3$(h)($PuNi_3$-type), La_2Rh_7(h_1)(Ce_2Ni_7-type), and La_2Rh_7(h_2)(Gd_2Co_7-type). La_5Rh_3 and La_5Rh_4 with undetermined structures also occur in the system. $LaRh_2$ undergoes a polymorphic phase transformation at 1240°C. $LaRh_3$ and La_2Rh_7 also exhibit polymorphism. The phases La_3Rh and La_2Rh_7 melt congruently. The latter undergoes a eutectoid transformation into $LaRh_3$ and Rh at 1205°C. La_5Rh_3 is formed by a peritectoid reaction between La_3Rh and $La_4Rh_{\sim 3}$. The other phases result from peritectic reactions between the liquid and the adjacent rhodium-rich phases. The intermediate phases of the La–Rh system are compared with those of the La–Co and La–Ni systems. (auth)

41662 TEXTURE INHOMOGENEITIES IN COLD-ROLLED NIOBIUM. Vandermeer, R. A.; Ogle, J. C. (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME, 245: 1511-18(July 1969).

Two distinct types of depth-dependent variations in texture have been observed in niobium cold-rolled various amounts up to 99.5% reduction in thickness. These nonuniformities are thought to be the results of nonhomogeneous plastic deformation during rolling. The first type is characterized by a zone at intermediate depths that tends to lack certain strong orientations which are present in the surface and center layers of the rolled stock. This type of texture modification seemed to be associated with high body rolling and may be related to the shape of the zone of deformation in rolling. The second type of texture inhomogeneity found involved the formation of a unique texture in the surface layers of heavily rolled strip. High friction forces between work piece and rolls appear to be needed to generate and maintain this texture. It appears that this unique surface texture results from a shear mode of deformation in the surface layers. (auth)

41663 KINETICS OF TRANSFORMATIONS IN THE β SOLID SOLUTION OF THE MAGNESIUM–INDIUM SYSTEM. Pickwick, K. M.; Alexander, W. A. (National Research Council of Canada, Ottawa). J. Less-Common Metals, 19: 105-12(Oct. 1969).

Decomposition of the intermediate β solid solution of the magnesium-indium system has been examined in respect of the characteristics and kinetics of the reactions, using a resistometric technique. The β phase undergoes ordering of the type Al $\rightarrow$ $L1_2$ (β') in alloys containing up to 39% indium, and Al $\rightarrow$ $L1_0$ (β'') between 39 and 55% indium. Both transitions occur with great rapidity, and the disordered state could not be retained at any temperature below T_c. This behavior is discussed with reference to the transformation kinetics expected of such first order reactions. Precipitation from the ordered solid solutions occurs within narrow homogeneity ranges at Mg_3In (β_1) and Mg_2In (β_2), although there are extensive two-phase regions about these compositions. The β_1 phase forms by continuous precipitation, and the formal kinetics of the reaction have been determined. For β_2, the precipitation changes from the continuous to the discontinuous mode as the indium concentration is increased through the stoichiometric composition. (auth)

41664 THE DISTRIBUTION OF DISLOCATIONS IN SPECIMENS OF COLUMBIUM AND COPPER AFTER DEFORMATION IN THE HOPKINSON BAR. Edington, J. W. (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME, 245: 1653-4(July 1969).

It is noted that the assumption that total stress and total strain do not vary significantly from point to point in specimens at any given instant during deformation using the Hopkinson bar is valid for short disc-type samples: its validity for larger samples is uncertain. Investigations of specimens prepared from single crystals of Nb and Cu using a split Hopkinson bar are discussed. It was found that dislocation density in Cu was constant whereas in Nb the density varied within the crystal. The implications of these findings are considered. (J.R.D.)

41665 KINETICS OF GRAIN BOUNDARY GROOVING IN CHROMIUM, MOLYBDENUM, AND TUNGSTEN. Allen, B. C. (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME, 245: 1621-32(July 1969).

Grain boundary grooving has been studied in chromium, molybdenum, and tungsten under a variety of conditions using high vacuum techniques and tantalum-gettered argon. The average surface free energy of solid chromium, and the chromium-liquid silver interface free energy were respectively found to be 2200 ± 250 and 500 ± 130 ergs per sq cm from groove formation kinetics and estimates of pertinent volume diffusion coefficients. The results for chromium were unaffected by variations in interstitial content ranging from 0.003 to 0.09% C, or 0.003 to 0.03% O. Surface diffusion is the primary mechanism of groove formation in chromium under 1 atm argon at 1200 to 1400°C, and is essentially unaffected by 0.003 to 0.09% C, 0.003 to 0.03% O, metastable nitrogen contents up to ~0.01%, and up to 2 torr Ag vapor. At higher temperatures, the major mechanism is volume diffusion in argon or evaporation-condensation in static vacuum. Surface diffusion occurs in molybdenum at 0.5 to 0.96 and in tungsten at 0.5 to 0.9 of the absolute melting temperature by a single mechanism, possibly by the migration of single adatoms or vacancies. Results were slightly affected by up to 23 torr Sn vapor, and in molybdenum were essentially unaffected by 0.5 Ti or carbon in the range 0.002 to 0.02%. Volume diffusion through the liquid is in mechanism of groove formation in chromium-liquid silver at 1200 to 1400°C and in molybdenum-, Mo-0.5 Ti-, and tungsten-liquid tin at 1200 to 2000°C. The solid-liquid interface free energies involved were estimated from grooving kinetics. (auth)

41666 AN ELECTRON-MICROSCOPE STUDY OF PRECIPITATION IN Cu–Be ALLOYS. Wilkes, P.; Jackson, M. M. (Univ. of Manchester, Eng.). Metal Sci. J., 3: 130-3(July 1969).

The mechanism of formation of G. P. zones and γ' precipitate, as revealed by electron microscopy, is reported for a range of copper-beryllium alloys. Individual zone images were obtained for alloys of lower Be content. The γ' precipitate is nucleated by G. P. zones when these are present. Above the G. P. zone solvus (~320°C) γ' is heterogeneously nucleated. (auth) (UK)

41667 THE ELECTRONIC STRUCTURE OF PURE METALS. PART A. ELECTRON THEORY OF PURE METALS. PART B. FERMI SURFACES AND PHYSICAL PROPERTIES OF SOME REAL METALS. Lomer, W. M.; Gardner, W. E. (Atomic Energy Research Establishment, Harwell, Eng.). Progr. Mater. Sci., 14: 97-171(1969).

The subjects are reviewed under the following main headings: Part A. Introduction; interaction energy terms; electron interactions; band theory; quasi-particle formulations. 34 references. Part B. Introduction; the alkali metals (Li, Na, K, Rb, Cs); the divalent hexagonal metals (Be, Mg, Zn, Cd); the semi-metals (As, Sb, Bi). (63 references) (UK)

41668 INVESTIGATIONS ON THE PRECIPITATION BEHAVIOUR AND THE MECHANICAL PROPERTIES OF THE ALLOY INCONEL 625. Garzarolli, Friedrich; Gerscha, Alf; Francke, Karl Peter (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). Z. Metallk., 60: 643-52(Aug. 1969). (In German).

Inconel 625 is a nickel base alloy, solid solution hardened by molybdenum and niobium. At temperatures between 550 and 750°C fine precipitates of a tetragonal phase Ni_3(Nb,Al,Ti) segregate, which raise hardness and strength. This phase is metastable. It overages at temperatures above 650°C after prolonged times in Ni_3(NbMo) with an orthorhombic structure and an acicular shape. Connected with overaging is an increase of the creep rate, whereas hardness and yield strength are less influenced by overaging. In alloys without aluminum and titanium precipitation of the tetragonal Ni_3(Nb,Al,Ti)-phase does not occur. Therefore such alloys exhibit nearly no hardness increase after exposure at high temperatures and less creep strength than alloys with aluminum and titanium addition. In melts with lower contents of molybdenum and niobium only a small amount of Ni_3(NbMo) is formed by overaging. (auth)

41669 SUPPLEMENT OF THE NICKEL–INDIUM SYSTEM. Best, Klaus Juergen; Goedecke, Tilo (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 60: 659-61(Aug. 1969). (In German).

The constitution of the nickel–indium alloys in the region from 20 to 70 at.% In and 400 to 1000°C has been reinvestigated. The phases Ni_2In and $Ni_{13}In_9$ are formed by a degenerate peritectoid reaction at 665 and 880°C, respectively. The NiAs phase ϵ has a limited region of stability. Alloys containing between 42 and 51 at.% In segregate eutectically from the melt. The β-phase solidifies with open maximum at approximately 950°C. (auth)

41670 CONTRIBUTION TO THE STUDY AT HIGH TEMPERATURE OF THE EQUILIBRIUM PHASE DIAGRAM OF THE TERNARY SYSTEM Cu–Nb–W. Allibert, Colette; Driole, Jean; Bonnier, Etienne (CNRS, Grenoble, France). Compt. Rend., Ser. C, 268: 2277-80(June 30, 1969). (In French).

Three isothermal sections of the ternary system Cu–Nb–W at 1600, 1900, and 2100°C were established. They gave evidence for a large two-phase region. The three diagrams are given plus the corresponding tables listing the composition of each sample studied and the composition of both solid and liquid phases of each. The composition of the liquid phase was determined by chemical analysis and that of the solid phase by electron microwave and x-ray diffraction analysis. (J.R.D.)

41671 A MICROSCOPICAL STUDY OF THE FRACTURE OF NIOBIUM-BASED ALLOYS. Chudarev, L. F. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 28, 28-35 (1968). (In Russian).

The microstructure of Nb-based alloys was studied after tensile tests at room temperature and torsion creep tests at high temperature. The fracture mechanism at room temperature of Nb–Mo alloys and also these alloys containing ≤1.0% Ti and Zr is associated with the build-up of cracks at grain boundaries and their propagation along the grains. At high temperature a study was made of the mechanism of deformation and of the nature of the accumulation and development of cracks at various stages of creep. (Referativnyi Zh.)

41672 INVESTIGATIONS IN THE NIOBIUM–ZIRCONIUM SYSTEM UP TO 30 WT. PERCENT NIOBIUM. Skladnikiewitz, S. (Forschungsinstitut fuer Nichteisenmetalle, Freiberg, Ger.). pp 88-99 of Eigenschaften und Anwendung Hochschmelzender und Reaktiver Metalle. Leipzig, Veb Deutscher Verlag fuer Grundstoffindustrie, 1968. (In German).

From Conference on Properties and Uses of Highly Fusible and Reactive Metals, Dresden, Germany. See CONF-670222.

X-ray, dilatometric, and resistance measurements were made of Zr–Nb alloys with Nb content from 3 to 30 wt %. The transformation pattern of the quenched alloys was determined. After quenching from the β_{Zr} range to room temperature the samples could be divided into five groups. The alloys with a Nb content less than 3 to 4 wt % were transformed martensitically into the Nb-saturated α' phase. In the concentration range of 5 wt % Nb, both the formation of the α' and the ω' phase occur. In the concentration range from 7 to 14 wt % Nb, where the ω_s temperature is higher than the ω phase formation temperature, the ω' and the and the Nb-saturated β^* phases exist. The alloys with 14 to 20 wt % Nb are transformed athermally and diffusionless into $\omega_0' + \beta_{Zr}$. The alloys with more than 20 wt % Nb are not transformed and the β_{Zr} mixed crystals present at high temperatures remain. (J.S.R.)

41673 INVESTIGATION OF THE SYSTEM Zr–Nb–V BY THE METHOD OF LOCAL X-RAY SPECTRAL ANALYSIS. Ronami, G. N.; Kuznetsova, S. M.; Sokolovskaya, E. M.; Raevskaya, M. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 26-30(Mar.-Apr. 1969). (In Russian).

X-ray microanalysis was used for investigating the thermal properties of Zr–Nb–V alloys. Isothermal cross sections were constructed for temperatures of 1000, 700, and 500°C. The intermetallic compound λ_1 was identified. (tr-auth)

41674 THE EFFECT OF THE MEDIUM [HEAT-TREATMENT ATMOSPHERE] ON THE STRUCTURE OF ZIRCONIUM. Krupin, A. V.; Chernyshev, V. N.; Solov'ev, V. Ya.; Izotov, V. M.; Mel'nikova, L. V. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 28, 74-9(1968). (In Russian).

The microstructure of Zr was studied after heat treatment in air and under low pressure. The surface gas-saturated layer of Zr acquires a characteristic striated structure, the appearance of which is explained by diffusion of impurities along certain planes. An increase in temperature accelerates diffusion and at 1200°C a similar structure is found across the whole section. There is marked grain growth in the temperature range 900 to 1200°C associated with a polymorphic transformation. (Referativnyi Zh.)

41675 RECRYSTALLIZATION [ANNEAL] OF MODIFIED MOLYBDENUM AND ITS ALLOYS. Mal'tsev, M. V.; Efremov, Yu. N.; Danielyan, T. A. Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal., No. 28, 5-13(1968). (In Russian).

A high-temperature anneal was the most suitable for obtaining a uniform structure and increased ductility of Mo. Recommended annealing regimes for billets and various components are described. An x-ray analysis method is given for studying processes that occur in the crystal lattice during the annealing of Mo and its alloys. (Referativnyi Zh.)

41676 TRANSFORMATION CHARACTERISTICS OF A Zr–4% VANADIUM ALLOY AND THE FORMATION OF THE METASTABLE ω PHASE. Borchers, H.; Saur, G.; Lehmann, W. (Institut fuer Metallurgie and Metalkunde, Munich). Atomkernenergie, 14: 273-83(July-Aug. 1969). (In German).

The $\beta \rightleftharpoons \alpha$-transformation in the zirconium–vanadium system was studied using hardness measurements and metallographic and x-ray diffraction techniques. The martensitic transformation was suppressed when the amount of the β-stabilizing element vanadium exceeded the critical level of about 3 wt %. However, when the alloy content was higher, the high temperature β-phase could not be quenched to room temperature without change. When the nominal composition was just above this critical level, β transforms in a diffusionless manner into the athermal ω'-phase. A complete retention of β was not possible. By analogy with the conventional diffusionless transformations the ω_S-temperature of the Zr–4 wt % V alloy was between 100 and 200°C. Whereas the metastable ω'-phase decomposed during subsequent aging into $\alpha + ZrV_2$, the retained β transformed primarily into the aged ω-phase, which was formed by a diffusion-controlled nucleation process. The formation of ω' or aged ω led to a considerable increase of hardness, while elongation decreased. The ω-platelets in the aged condition could be considered as initial nuclei for the formation of the room temperature α-phase. Whereas after quenching and subsequent aging the high temperature β-phase transformed into α by formation of the various metastable ω-phases, it was found that β was directly transformed into $\alpha + ZrV_2$, when the specimens were quenched to temperatures above 530°C. The activation energies of the various transformation products were measured. The kinetics of the transformation became clear by plotting the experimental results into a tentative TTT-chart. (auth)

41677 KINETICS OF BETA-PHASE DECOMPOSITION AND THE PRECIPITATION OF ALPHA–ZIRCONIUM IN Nb–40 AT. PERCENT Zr–10 AT. PERCENT Ti SUPERCONDUCTING ALLOY. Soeno, Ko; Kuroda, Teturo (Hitachi, Ltd., Japan). Nippon Kinzoku Gakkaishi, 33: 791-5(July 1969). (In Japanese).

The kinetics of the beta-phase decomposition and the precipitation of alpha-zirconium were investigated by measuring the changes in electrical resistivity at liquid nitrogen temperature. The reaction in the miscibility gap region was carried out by heating the specimens of the beta-phase to a given temperature. The effect of cold work on the rates of the decomposition was also investigated. The kinetics of the decomposition are conveniently described using T-T-T curves between 650 and 800°C. Two modes of the decomposition, continuous and discontinuous types, were observed and their processes were assumed to be affected not only by the decomposition temperature but also by the amount of cold working. Consequently, somewhat complex T-T-T curves were obtained. A general acceleration of the decomposition caused by cold working is also given in the T-T-T curves. The precipitation of alpha-zirconium was investigated by using the specimens previously decomposed in the miscibility gap region. The rates of the precipitation and the effect of cold working on the rates are described with T-T-T curves between 400 and 550°C. (auth)

Radiation Effects

Refer also to abstracts 40873, 42389, 42391, 42392, 42399, 42414, 42420, 42425, 42440, and 42443.

41678 (AECL-3308) FAST NEUTRON DAMAGE IN ZIRCONIUM-BASED STRUCTURAL ALLOYS. Williams, C. D.; Gilbert, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 15p. (CONF-690620-3; SM-120/C-3). Dep. CFSTI (U. S. Sales Only). CAN $0.50.

From Symposium on Radiation Damage in Solids and Reactor Materials, Vienna, Austria.

Damage accumulation in Zircaloy-2 irradiated to fluences of up to 10^{22} n/cm^{-2} at ~300°C is described with an account of the defect behavior during post-irradiation annealing. Transmission microscopy of Zircaloy-2 pressure tube and fuel sheath materia irradiated at 260 to 320°C has shown that the total visible density of the clusters and loops increases initially with fluence reaching a saturation value of $\sim 3 \times 10^{16}$ cm^{-3} after irradiation at 2 to 3×10^{20} n/cm^{-2} (E > 1 MeV); this density does not increase significantly with longer irradiation at these temperatures. However, the size spectrum of the clusters and loops changes so that the spectrum peak shifts from 50 Å after 4×10^{19} n/cm^{-2} to 100 Å after a fluence of 2×10^{21} n/cm^{-2}. Irradiation strengthening exhibits a reduced dependence on fluence in this range, and is related to the inter-obstacle spacing associated with the defect distribution. No evidence is found either of the growth of dislocation loops to diameters greater than 200 Å or of the formation of complex tangles by interaction of loops during these irradiations. No evidence is found for the formation of three dimensional voids of the type reported in steels subjected to high fluences at 350 to 560°C, either in Zircaloy-2 irradiated to $>10^{21}$ n/cm^{-2} ~300°C or in similar material irradiated in the Dounreay Fast Reactor to a fluence of $\sim 4 \times 10^{21}$ n/cm^{-2} at ~500°C. The irradiation damage formed in the latter material is apparently similar to that obtained at ~300°C and shows similar behavior during post-irradiation annealing treatments, viz. annihilation of the smaller defects and growth of dislocation loops to diameters of up to ~300 Å is observed. Loop expansion and interaction results in an increase in line dislocation density. Defect recovery is found to be strongly dependent upon annealing temperature but is not markedly dependent on fluence accumulated before annealing. (auth)

41679 (AECL-3363) THE EFFECT OF FAST NEUTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF SOME STAINLESS AND LOW-ALLOY STEELS. Hosbons, R. R.; Wotton, B. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1969. 41p. Dep. CFSTI (U. S. Sales Only). CAN $1.00.

An experiment was undertaken to find the effect of fast neutron irradiation on present and candidate pressure tube end-fitting materials. Mechanical test specimens were irradiated to an integrated neutron flux of 6×10^{19} n/cm^2 in pressurized water at 300°C simulating end-fitting service. The change in transition temperature for these materials was found to be ~70°C for AISI 403 and 431 stainless steels and 15°C for SA335 P22, a $2\frac{1}{4}$ Cr-1 Mo low alloy steel. The $2\frac{1}{4}$ Cr-1 Mo low alloy steel is recommended for use as the end-fitting material in future power reactors. (auth)

41680 (CONF-670846-, pp 208-51) RADIATION EFFECTS IN SOLIDS. Holmes, D. K. (Oak Ridge National Lab., Tenn.).

Information on radiation damage in solids is reviewed. Discussions are included on stages of radiation damage, radiation effects on electric conductivity, computer simulation of radiation effects, channeling phenomena, radiation effects at low temperatures, annealing radiation effects, interstitials and vacancies, effects of electrons, and pair annihilation theories. (J.R.D.)

41681 (COO-1161-6) STUDIES OF RADIATION DAMAGE RESULTING FROM ELECTRON BOMBARDMENT. Final Report, April 1, 1968–June 30, 1969. Kauffman, J. W. (Northwestern Univ., Evanston, Ill. Dept. of Materials Science). Contract AT(11-1)-1161. 39p. Dep. CFSTI.

Low temperature study results were used as the basis for a model of Stage I recovery in fcc metals. Processes in this model are effected by competition for freely migrating interstitials between vacancies for annihilation, impurity atoms for trapping, and interstitials for mobile cluster formation. The volume change of refractory oxide single crystals due to electron irradiation was also investigated. The refractory oxides are a class of insulating materials which have many physical properties in common with the more extensively studied alkali halides but have a mixed covalent-ionic bonding which appears to have significance to the radiation damage mechanism in these materials. The length change results are consistent with the idea that the contraction observed in MgO at low incident electron energies is correlated with the production of V_1 centers and the expansion produced at higher energies is related to the production of F-type centers. A sharp transition from contraction to expansion is observed at an energy which we conclude is the threshold energy for the displacement of oxygen atoms in MgO. This result lends further support to the idea that defect production in MgO occurs primarily as the result of elastic collisions. In other research, radioinduced quantitative migration of point defects in Au–Ag alloys were investigated using thin films of modulated composition. Studies aimed at gaining better understanding of radiation damage in metals by atomic replacement collision sequences are in progress. The effort on this research during the report period was devoted to equipment fabrication and methods development. (J.R.D.)

41682 (EURAEC-2087) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Final Report. Castagna, M.; Chinaglia, B.; Ferro, A.; Montalenti, G.; Monti, D.; Rossi, F. S.; Soardo, G. P.; Szabo Miszenti, G. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Oct. 1968. Contract 074-65-10-TEEI (RD). 202p. (EUR-4008; M-567). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Investigations of iron and iron alloys are reported concerning the effects of strain rate on yielding and plastic flow of interstitial-free specimens with small Ti additions. These results are compared with those obtained in tests of similar specimens exposed to fast neutron irradiation. Other work is summarized on the effects of fast neutron irradiation on Fe–6.5 Si alloys with magnetorestriction and on 50% recovery from embrittlement in iron and steel. Experiments designed to establish neutron dosimetry for use in correlations with results of iron and steel irradiations are described. Dosimetry data on Ni-base iron alloys are correlated with magnetic properties of these alloys. Data are also included on mechanical properties of quenched and tempered steels. (J.R.D.)

41683 (ORNL-TM-2645) ELECTRON MICROSCOPE IN SITU ANNEALING STUDY OF VOIDS INDUCED BY IRRADIATION IN ALUMINUM. Packan, N. H.; Braski, D. N. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

The shrinkage of irradiation-induced voids in 8001 aluminum alloy and pure aluminum (Cominco Grade 69) was investigated by annealing thin-foil specimens in a high-vacuum electron microscope. The general shrinkage characteristics of both materials were quite similar, but the shrinkage curves for individual voids showed considerable variation. Most of the voids exhibited an initial high rate of shrinkage. Both effects may reflect the influence of unresolvable local vacancy sinks. (auth)

41684 NEUTRON IRRADIATION EMBRITTLEMENT OF REACTOR PRESSURE-VESSEL STEELS. Steele, L. E. (Naval Research Lab., Washington, D. C.). At. Energy Rev., 7: 3-133(1969).

The embrittlement data are reviewed to demonstrate the specific effects of several environmental and materials factors with emphasis on those appropriate to light-water reactor service. The implications of large variations in embrittlement are highlighted to indicate the potential for minimizing steel embrittlement. Data for experimental studies and from reactor-vessel surveillance programs are correlated with emphasis on the role of different nuclear environments. Recent developments which suggest several alternatives for correcting embrittlement or minimizing its effects in current reactors and possibly for avoiding it in future reactors are also reviewed. It is impossible to cover all aspects of radiation embrittlement of all reactor-vessel steels. Accordingly throughout the review, those aspects considered most important to the ultimate engineering use of the results are emphasized and supported by examples from experimental data. (J.R.D.)

41685 EFFECT OF REACTOR IRRADIATION ON THE INTERNAL SURFACE AREA OF CORROSION FILMS ON ZIRCONIUM ALLOYS. Asher, R. C.; White, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 223: 497(Aug. 2, 1969).

Studies were made on pre-corroded tubular specimens of Zircaloy-2 and Zr/2.5% Nb alloy, using the ^{133}Xe adsorption BET technique at 77°K. The corroding environments were steam or moist CO_2/air at 300° to 480°C. Irradiation was in the DIDO reactor at ~3×10^{13} n/cm^2/sec. >1 MeV, and 10^8 to 10^9 R/hr γ. Degrees of corrosion were expressed as increase in weight per dm^2. It was found that irradiation consistently increased the surface area. Different behavior was shown by the irradiated specimens as compared with those unirradiated. A relatively short irradiation period increased the surface area dramatically, and the observations were consistent with the suggestion that the corrosion enhancement was associated, at least in part, with irradiation embrittlement of the film, which leads to extensive breakdown and hence increase in internal surface area. (UK)

41686 DETERMINATION OF FOIL THICKNESS AND VOID SIZE FROM ELECTRON MICROGRAPHS OF IRRADIATED AUSTENITIC ALLOYS. Wolff, Ursula E. (General Electric Co., Pleasanton, Calif.). Metallography, 2: 89-100(Mar. 1969).

Since irradiation-induced swelling of austenitic alloys has been traced to void formation, quantitative determinations of void size, size distribution, and volume fraction have become important. Such measurements are made on electron micrographs of thin foils whose thicknesses must be known to make quantitative calculations possible. By adapting a recent method of determining the foil thickness of alloys containing precipitates to the present problem of alloys containing voids, reasonable values within the expected range were obtained for the thickness of the specimen foils investigated. Furthermore, void volume fractions determined with these foil thicknesses showed good correlation with the bulk density changes observed in Types 304 and 347 stainless steel and Incoloy 800. (auth)

41687 MODEL FOR CHANNEL BEHAVIOR DURING CYCLIC DEFORMATION OF NEUTRON IRRADIATED COPPER. Adamson, R. B. (Atomic Energy Research Establishment, Harwell, Eng.). Acta Met., 17: 1169-74(Sept. 1969).

Cyclic strain experiments were conducted to determine the widening behavior of cleared channels in neutron irradiated copper as a function of applied reverse strain per cycle. It was found that widening occurs during only a portion of each cycle. A model is developed which explains this and other experimental observations in terms of the effect of stress fields surrounding clusters of dislocation dipoles which are found in the channels. (auth)

41688 HELIUM EMBRITTLEMENT OF TYPE 316 STAINLESS STEEL. Kramer, D. (Atomics International, Canoga

Park, Calif.); Garr, K. R.; Rhodes, C. G.; Pard, A. G. J. Iron Steel Inst. (London), 207: 1141-6(Aug. 1969).

Helium was injected into small tensile samples of type 316 stainless steel by α-particle irradiation from a cyclotron. Subsequent tensile testing in the temperature range 540° to 815°C revealed a loss of ductility, as measured by elongation at failure. The lowest temperature at which a ductility loss was manifest depended upon the microstructure of the samples. A fine dispersion of sigma particles within the matrix was capable of raising this temperature by retarding the accumulation of helium at grain boundaries. Reduced ductility was always accompanied by partial or complete intergranular failure and the presence of intergranular cracks. These cracks originated as small voids adjacent to grain-boundary carbide particles, presumably through the action of grain-boundary sliding. Large helium bubbles found attached to carbide particles were responsible for the relative ease of void formation, as compared to samples without helium. (auth) (UK)

41689 NEUTRON IRRADIATION TEST ON REACTOR PRESSURE VESSEL STEEL (A302B STEEL) WELDMENT. Fujimura, Tadato; Nakazaki, Chozaburo (Japan Atomic Energy Research Inst., Tokai). Yosetsu Gakkaishi, 38: 608-14(June 1969). (In Japanese).

The fast-neutron irradiation embrittlement of structural steels is an important problem in the design of pressure vessels for nuclear power reactors. Many studies have been made on the irradiation embrittlement of steels in foreign countries. In Japan, plans are also in progress on the irradiation tests of domestic structural steels, and some have already been carried out. The results of irradiation tests in JRR-2 and of postirradiation tests of ASTM A302B steel, aluminum-killed steel, and their weld metals are presented. Information is included on irradiation conditions in JRR-2, test rig for irradiation, apparatus for the post-irradiation test, and results of irradiation embrittlement tests and tensile tests. It was found that the transition temperature shifts for brittle fracture at 6 ~ 9 n/cm^2 neutron doses were 67°C on A302B base metal, 107°C on its weld metal and 95°C on its bond metal. The change of tensile property due to neutron irradiation in aluminum-killed steel was larger than in A302B steel. (auth) (NSA of Japan)

41690 ACTION OF PENETRATING γ RADIATION ON PRIMARY CRYSTALLIZATION OF CAST IRON. Drobyazin, V. N.; Konozenko, I. D.; Popovich, M. M.; Gorshkov, A. A. (Inst. of Physics, Kiev. Inst. of Foundry Problems, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 6, 555-9(June 1969). (In Russian).

The effects of penetrating γ-radiation on the processes of primary crystallization of cast iron are established and possibility of using γ-radiation at high rates as a means of changing the physicochemical properties of cast iron are considered. (auth)

41691 EFFECTS OF NEUTRON IRRADIATION ON AGING CHARACTERISTICS OF COPPER-1.5 AND 2.0 WT PERCENT BERYLLIUM ALLOYS. Yoshida, Hiroyuki; Murakami, Yotaro (Kyoto Univ., Osaka). Nippon Kinzoku Gakkaishi, 33: 775-81 (July 1969). (In Japanese).

The post-irradiation aging characteristics of copper-9.5 and 12.6 at. % beryllium-0.2 at. % zinc alloys which had been quenched or pre-aged before irradiation have been investigated by electrical resistivity measurement, micro-Vickers hardness test, electron microscopic observation, and electron diffraction method. The increment in resistivity by irradiation decreased with decreasing supersaturation of beryllium in the matrix of specimens. The large resistivity increase by irradiation in the supersaturated specimens is mainly attributed to G.P. zones formed during irradiation. The isothermal aging curves for the irradiated specimens at 250°C consist of two stages. The first stage is interpreted as due to the dissolution of G.P. zones formed during irradiation. On the early period of the second stage, an appreciable precipitation of intermediate γ' phase was observed, which is considered due to the enhanced nucleation by irradiation. (auth)

Ceramics and Cermets

Refer also to abstracts 40915, 41528–41530, 41533–41537, and 41613.

41692 (UCRL–18735, pp 129-52) CERAMIC SCIENCE. (California Univ., Berkeley. Lawrence Radiation Lab.).

Research progress is reported on ground states of high temperature vapor species, sublimation of CrO_3, thermal properties of SnF_2, variations of Zn (0001) surface sublimation, Zn single crystals sublimation kinetics of evaporation and condensation, energy states of P_4 molecules, interdiffusion in NiO, interdiffusion in CaO, interdiffusion in MgO, densification of MgO, wetting MgO by silicates, reactions between Al_2O_3 and SiO_2, creep of polycrystalline LiF, creep of MgO, iron oxide dissolution, thermodynamic properties of disilicate glass, wetting sapphire by liquid Al, flaws in glass matrix composites, strengthening brittle matrix composites, gas permeation in fused silica and properties and structure of lead zirconium titanates. (J.R.D.)

41693 NONISOTHERMAL ELECTROMOTIVE FORCE OF GALVANIC CELLS WITH ZIRCONIA-LIME OR THORIA-LIME ELECTROLYTE. Goto, Kazuhiro; Ito, Takeyasu; Someno, Mayumi (Tokyo Inst. of Tech.). Trans. Met. Soc. AIME, 245: 1662-3(July 1969).

An evaluation of the thermoelectromotive force coefficient for zirconia-lime and thoria-lime under isobaric conditions is presented. Methods of calculating apparent coefficients are presented and diagrams are included showing the isoelectromotive force lines for these couples. It is concluded that the electromotive force of the Galvanic cell under non-isothermal and isobaric conditions is predominantly determined by the chemical potential difference at the two electrodes but the thermoelectromotive force cannot be neglected. The coefficient of thermoelectromotive force seems independent of temperature. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 41542.

41694 APPLICATION OF WETTING THEORY TO THE NON-REACTIVE LIQUID METAL–GRAPHITE SYSTEMS. Buhsmer, C. P.; Heintz, E. A. (Airco Speer Research Lab., Niagara Falls, N. Y.). J. Mater. Sci., 4: 592-5(July 1969).

An attempt was made to correlate the published contact angle data for graphite-liquid metal systems with the theory of liquid-solid wetting phenomena. To establish the reasonableness of the approach, the potential expression for dispersion interaction was employed for mercury, and the magnitude of the contribution from dispersion forces to the liquid surface energy of mercury, γ_L^d, was calculated to be 193 erg/cm^2. This compares favourably with the published experimental value of 200 erg/cm^2. Similarly the γ_L^d values for liquid metals of known contact angle with graphite were calculated and subsequently substituted in a modified Young equation in order to calculate the respective values of Φ. The parameter, Φ, is defined as the ratio of adhesion and cohesion forces for any two phases in contact. The calculated values of Φ were observed to rise to a maximum for all metals in the same periodic group as carbon, which would be predicted for "chemically similar" phases. (auth) (UK)

41695 CORROSION RESISTANCE OF NICKEL/2.5 PERCENT THORIA ALLOY AT ELEVATED TEMPERATURES. Fontaine, P. I. (International Nickel, Ltd., Birmingham, Eng.). Brit. Corros. J., 4: 154-61(May 1969).

Nickel can be appreciably strengthened by the addition of a fine dispersion of submicron-size particles of thoria. At temperatures above 1000°C the stress-rupture strength of Ni/2.5% thoria alloy produced by mechanical mixing and extrusion is greater than that of the strongest wrought Ni/Cr creep-resistant alloys. However, successful service application depends also on satisfactory resistance to corrosion at elevated temperatures. Corrosion resistance of Ni/2.5% thoria alloy to high-temperature oxidation and sulfidation was evaluated, in comparison with that of Ni and a commercial Ni/20% Cr alloy. In sulfur-containing simulated fuel-ash and gaseous environments the resistance of the Ni/thoria approached that of Ni/Cr. The observed dependence of corrosion rate on temperature is explicable on the basis of thermodynamic considerations. In a simulated vanadium-containing fuel-ash the Ni/thoria alloy retained the good resistance of Ni, but in oxidation by quiescent air it showed little improvement. However, in temperature-cycled conditions the thoria dispersion conferred excellent resistance to spalling of the oxide. (BBB)

41696 EFFECT OF OXYGEN PRESSURE AND CARBON BURN-OFF ON THE PRODUCT RATIO OF THE CARBON–OXYGEN REACTION. Phillips, Roger; Vastola, F. J.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park). Carbon, 7: 479-85(Aug. 1969).

The reaction of Graphon with O_2 was studied at 625°C in a static system, using initial O_2 pressures between 25 and 750 mtorr and samples pre-oxidized to varying degrees of burn-off between 0 and 20%. The reaction temperature was low enough for secondary reactions to be neglected. A mass spectrometer was used to monitor the partial pressures of O_2, CO and CO_2. After a brief induction period corresponding to the formation of a stable complex on the carbon surface, the incremental product ratio CO/CO_2 became constant. This product ratio increased with initial carbon burn-off and decreased with initial O_2 pressure. Stable complex formation increased with initial carbon burn-off and initial oxygen pressure. It is suggested that for a particular burn-off the product ratio is a function of both the amount of stable complex on the surface and the relative extent to which CO and CO_2-generating sites are deactivated by stable complex formation. (auth) (UK)

41697 ACTION OF AIR BETWEEN 25 AND 620°C ON AN ACTIVE CARBON BLACK. Lang, F. M.; de Noblet, M.; Brie, M. (CEN, Saclay, France). Carbon, 7: 433-42(Aug. 1969). (In French).

A highly reactive product was obtained from Spheron 6 purified in chlorine at 1800°C, oxidized by air at 620°C, and finally degassed under vacuum or in a current of argon at 900°C. This product was placed in contact with air under atmospheric pressure at temperatures between 25°C and 620°C. When the surface complexes thus formed were thermally destroyed in a current of argon or under vacuum, CO and CO_2 appeared in well-defined temperature zones. It is suggested that oxidation takes place through the agency of at least two types of active sites. (auth)

Preparation and Fabrication

Refer also to abstracts 40936, 41573, 41590, and 41596.

41698 (AI-AEC-Memo-12724) OPTIMIZATION OF MELTING PARAMETERS FOR FABRICATION OF (U–Pu)C. Carroll, J. W.; Young, W. A.; Graves, A. W. (Atomics International, Canoga Park, Calif.). July 2, 1968. 14p. Dep. CFSTI.

A theoretical study on the loss, by volatilization, of Pu from (U – 20 wt % Pu)C was completed and indicated that the loss rate would be reduced by a factor of 3000 by melting in one atmosphere of argon as opposed to melting in a vacuum. Results of crucible geometry studies (without a heat transfer analysis) indicated that a hemispheric crucible would be an optimum design to minimize the amount of skull within the crucible. Heat transfer studies, partially completed, may disqualify the hemispheric shape due to the extremely large heat loss from the open crucible top which would necessitate extremely large power inputs, possibly long melting times and consequently larger Pu losses. (auth)

41699 (AWRE-O-24/69) GLAZING DEFECTS IN THE CONSTRUCTION OF MULTILAYER CIRCUITRY FOR COMPUTERS. Buck, R. H. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1969. 21p. Dep. CFSTI (U. S. Sales Only). UK 5s. 0d.

The requirements of an air-fired glaze and a vacuum-evaporated metal conductor system as part of a multilayer interconnection module are discussed. In particular, the compatibility of the constructional materials in the process environment of the system is illustrated by the occurrence of glazing and conductor defects where use is made of a screen-printed commercial lead-containing glaze and evaporated gold–chromium conductors. One type of glazing defect, resulting from the use of an otherwise ideal commercial glaze, has been examined in an effort to determine its origin. Preliminary results are presented. (auth) (UK)

41700 (INR-1050) THE CONSTRUCTION EQUIPMENT OF PRESS PHM 400 FOR IMPRESSING FUEL ELEMENTS OF THE WWRM TYPE. Kochanski, Tadeusz (Institute of Nuclear Research, Warsaw (Poland)). 1968. 15p. (In Polish). Dep.

A description of the construction equipment press PHM 400 for impressing fuels elements of the WWRM type is given. An approximative method of calculation of endurance matrix and plate is given. A method of calculation of furnace heating element is also described. The description of the construction is illustrated. (auth)

41701 (ORNL-4426) FABRICATION OF SOL-GEL-DERIVED THORIA-URANIA BY COLD PRESSING AND SINTERING. Robbins, J. M.; Stradley, J. G. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 18p. (CONF-670557-1). Dep. CFSTI.

From 69th American Ceramic Society Meeting, New York.

The use of the cold-press-and-sinter technique for producing sol-gel thoria-urania fuel pellets was investigated. Sol-gel powder calcination temperature, moisture content, uniaxial and isostatic forming pressures, and sintering atmospheres were studied. The sol-gel powder was characterized by DTA, TGA, and BET surface area techniques. The sintered fuel pellets were evaluated in terms of shrinkage, density, and oxygen-to-uranium ratio. Shrinkages ranged from 16 to 20%, bulk densities ranged from 78 to 95% of theoretical, and the oxygen-to-uranium ratio was changed from 2.67 to 2.00 by hydrogen reduction. (auth)

41702 (ORNL-TM-2516) MICROSPHERE FORMING CONDITIONS FOR ThO_2–UO_3 SOLS: A FACTORIAL EXPERIMENT. Notz, K. J.; Meservey, A. B. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

The effects of three variables related to the sphere forming column solvent (2-ethyl-1-hexanol) on the properties of microspheres produced from ThO_2-UO_3 sols were examined by means of a 2^3 factorial experiment. The three variables tested were: water content (0.4 and 1.6 vol %), acid concentration (0.001 and 0.01 N), and Ethomeen S/15 content (0.05 and 0.5 vol %). Representative photographs of the product microspheres are included. It was found that the solvents having low Ethomeen concentrations gave products with the least cracking and deformation. Also, it was shown that two solvent cross effects are prominent, namely, Acid x Ethomeen, and Water × Ethomeen. The nature of these cross effects is such that an improved product yield is obtained when the acid and the Ethomeen concentrations in a given solvent are balanced (i.e. either both high or both low), and when the water and Ethomeen concentrations are not balanced. Solvents with low acid and Ethomeen concentrations and a high water concentration satisfy these conditions. Other, less-general solvent effects were also noted. Five ThO_2–UO_3 sols were tested in each of the eight solvents comprising the factorial design. Four of the sols had been prepared by concurrent solvent extraction, and two of these had been digested at 100°C, either during or after the concentrating step; the digested sols gave the highest-quality microspheres. The fifth sol was prepared by countercurrent extraction and had a low nitrate/metal ratio; it also gave relatively good microspheres. The factorial design was replicated with three of the sols; in general, replication was good, although a number of prominent differences occurred. The significance of these differences is discussed. (auth)

41703 MANUFACTURE OF NUCLEAR FUEL. Horsley, Geoffrey Winton (to United Kingdom Atomic Energy Authority). U. S. Patent 3,457,334. Priority date Mar. 11, 1966, Great Britain.

A process is described in which particles of nuclear fuel oxides (or the like) are coated with pyrolytic carbon in an atmosphere into which carbon monoxide has been introduced from an extraneous source, preventing losses by the evolution of volatile oxides. (Offic. Gaz.)

41704 METHOD OF REMOVING CARBON FROM MIXTURES OF TUNGSTEN POWDER AND THORIA AND INSURING A UNIFORM DISPERSION OF THORIA. Cerulli, Nicholas F. (to Westinghouse Electric Corp.). U. S. Patent 3,451,803. Filed Nov. 10, 1966.

A method is described for removing carbon from a mixture of tungsten powder and thoria while simultaneously insuring a uniform dispersion of the thoria in the tungsten powder, in which the carbon in the mixture is present either as an impurity, or as an additive, or as both an impurity and an additive, in such amount that the total gram-moles of thoria in the mixture are at least and preferably more than one-third of the total gram-atoms of carbon in the mixture. The method comprises heating the mixture in an inert atmosphere or a vacuum at a predetermined temperature for a sufficient time to react all of the carbon present with thoria in the mixture to form thorium carbide; cooling the reacted mixture; exposing the cooled mixture to moisture for a sufficient time to hydrolyze all of the formed thorium carbide; and heating said hydrolyzed mixture under non-reactive conditions at a temperature of at least 100°C for a sufficient time to volatilize residual water. (Office Gaz.)

41705 PROCESS FOR PREPARING MULTI-COMPONENT NUCLEAR FUELS. (to W. R. Grace and Co.). British Patent 1,159,520. July 30, 1969. Priority date Sept. 25, 1967, United States.

A process is described for preparing a nuclear fuel comprising the oxides of at least two actinide metals, which involves contacting porous microspheres of a fertile nuclear material with a fissionable material in fluid phase to impregnate the microspheres with the fissionable material, and then converting the fissionable material to insoluble form. This may be accomplished by impregnating the microspheres with a sol or with a solution preferably an aqueous solution, of a salt of the fissionable component followed by conversion to the oxide in the pores of the matrix. The microspheres can also be impregnated with the additive in gaseous form (PuF_6, UF_6, etc.) followed by precipitation in the pores and conversion to the oxides. (J.R.D.)

41706 COBALT-BONDED TUNGSTEN CARBIDE. Meadows, Geoffrey W. (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,451,791. Filed Aug. 16, 1967.

Hard metal compositions of tungsten carbide bonded with 1 to 30 percent by weight of cobalt useful as cutting tools or bits for cutting or shaping very hard materials and a process for preparing the bonded compositions by heating an intimately mixed cobalt/tungsten carbide powder to a temperature above 1000°C and consolidating the powder to a density in excess of 95% of its theoretical density. (Offic. Gaz.)

41707 URANIUM DIBORIDE: PREPARATION, ENTHALPY OF FORMATION AT 298.15°K, HEAT CAPACITY FROM 1° TO 350°K, AND SOME DERIVED THERMODYNAMIC PROPERTIES. Flotow, H. E.; Osborne, D. W.; O'Hare, P. A. G.; Settle, J. L.; Mrazek, F. C.; Hubbard, W. N. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 583-92(July 15, 1969).

A sample of uranium diboride was prepared and characterized as $UB_{1.979\pm0.006}$ with 0.06 ± 0.03 wt % of identified impurities. The standard enthalpy of combustion in fluorine was determined to be -1021.2 ± 1.1 kcal $mole^{-1}$. The heat capacity was measured from 0.84 to 350°K. At 298.15°K the heat capacity C_p^0, entropy S^0, and enthalpy increment $H^0 - H_0^0$ are 13.23 ± 0.03 cal $K^{-1} \cdot mole^{-1}$, 13.17 ± 0.03 cal$°K^{-1} \cdot mole^{-1}$, and 2108 ± 4 cal $mole^{-1}$, respectively. The following values were obtained for the standard enthalpy, entropy, and Gibbs energy of formation of UB_2 at 298.15°K: $\Delta Hf^0 = -39.3 \pm 4.0$ kcal $mole^{-1}$, $\Delta Sf^0 = -1.54 \pm 0.05$ cal$°K^{-1} \cdot mole^{-1}$, and $\Delta Gf^0 = -38.8 \pm 4.0$ kcal $mole^{-1}$. These agree within experimental error with values calculated from high-temperature effusion measurements. The heat-capacity results below 4.2°K follow the equation $C_P = (9.40 \pm 0.01)\ T + (3.18 \pm 0.14) \times 10^{-2} T^3$ mJ $°K^{-1} \cdot mole^{-1}$. The relatively high value for the coefficient of the linear term indicates that uranium diboride is a good electrical conductor. There seems to be an anomaly in the heat capacity between 40 and 100°K, which may be due to a two-level Schottky anomaly with the upper level having a degeneracy twice that of the lower level and a separation of the levels equal to 175° ± 5°K or 122 ± 4 cm^{-1}. (auth)

41708 NEW MANUFACTURING PROCESS FOR UO_2 PELLETS WITH DENSITY CONTROLLED BY A DISACTIVATION TREATMENT. Flipot, A. J.; Gilissen, R.; Smolders, A. (CEN, Mol, Belg.). Energ. Nucl. (Paris), 11: 167-73(May 1969). (In French).

The density of UO_2 pellets obtained according to a given fabrication cycle, can be kept under control and modified by a thermal deactivation treatment. This treatment is carried out in a carbon dioxide gas stream on a precompressed and granulated product. The deactivation parameters such as time, thermal treatment temperature including the properties of the greens, which control the characteristics of the sintered pellets are discussed. This method can be applied to a wide range of densities satisfying the requirements for thermal and fast reactors. The most important advantages of this new process are simplicity of the operational technique, versatility of the method and reproducibility of the dimensional characteristics of the pellets. (auth)

41709 THE IMPORTANCE OF THE LANGMUIRSCHICHT FOR THE DEPOSITION OF PYROCARBON. Luhleich, Hartmut (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt, Geesthacht, Ger.). Atomkernenergie, 14: 293-4(July-Aug. 1969).

Results show that pyrocarbon can be formed around a graphite rod heated to 2000°C in methane at about 100 torr. The red hot zone around the rod known as the Langmuirschicht (Langmuir layer) consists of a plasma mainly containing positive ions. The pyrocarbon is formed in this zone. (J.R.D.)

41710 METAL BORIDE–METAL CARBIDE–GRAPHITE DEPOSITION. Diefendorf, Russell J. (to General Electric Co.). U. S. Patent 3,458,341. Filed Aug. 10, 1964.

A metallic boride-graphite deposit is described which may include metal carbide formed by use of an operating temperature of 1300 to 2500°C, and a pressure of from 0.5 to 100 millimeters of mercury employing a gaseous metal compound such as a metal halide, metal carbonyl, or organometallic; a second gaseous compound such as boron trichloride or trimethylborate, and a third gaseous material which is a hydrocarbon. (Offic. Gaz.)

41711 HIGH-PRESSURE SYNTHESIS OF YTTRIUM–THORIUM SESQUICARBIDE: A NEW HIGH-TEMPERATURE SUPERCONDUCTOR. Krupka, M. C.; Giorgi, A. L.; Krikorian, N. H.; Szklarz, E. G. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 19: 113-19(Oct. 1969).

A new, high-temperature superconductor, yttrium–thorium sesquicarbide, has been prepared by high-pressure–high-temperature techniques. The phase, crystallizing in the bcc, Pu_2C_3-type structure, exists over a wide ternary field. Lattice parameters are dependent on the Y/Th metal and C/M_T carbon-total metal atomic ratios. The material is superconducting with a variable transition temperature, having a maximum at 17.0°K. High-temperature ambient pressure annealing results in the destruction of both the bcc structure and the high-temperature superconductivity. A ternary bct phase, previously unreported, has been identified in a number of arc-melt preparations. This phase exists over a wide ternary field and is not superconducting down to 4°K. Elements other than thorium have been incorporated in yttrium sesquicarbide with resultant enhancement of the superconducting temperature. (auth)

41712 NUCLEAR FUEL ROD. Murota, Kazuo (to Nippon Atomic Industry Group Co.). Japanese Patent 1969-7237. Mar. 29, 1969. Filed Jan. 19, 1965.

A method is proposed in which the requirements for low- and high-density powdered fuel in a nuclear fuel rod can be met at the same time. The resulting advantages are as follows: for the high density fuel, increase in the specific power output, improvement in heat conduction, reduction in the release of produced fission products, etc., and for the low density fuel, relaxation of the thermal expansion and the irradiation deformation in the fuel rod itself, furthermore, simple process for fuel rod construction, and relatively low cost production. In producing a fuel rod containing sintered fuel powder, the density of fuel was high in the center along the axis and low in the remaining peripheral region. The actual production of this fuel rod can be accomplished by preparing the cylindrical central portion and the hollow outer portion separately, and then joining them or by preparing the already-two-region pellets first and then assembling them into a rod. (NSA of Japan)

41713 PRODUCTION AND UTILIZATION OF URANIUM IN NUCLEAR REACTORS (WITH SPECIAL REFERENCE TO RESEARCH INTO THE PRODUCTION OF CERAMIC-GRADE UO_2 IN AUSTRALIA). May, J. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). pp 161-82 of Symposium on Uranium in Australia, Held at Rum Jungle, Northern Territory, Australia, June 16-21, 1968. Berkman, D. A.; Cuthbert, R. H.; Harris, J. A. (eds.). Rum Jungle, Northern Territory, Australia, Australasian Institute of Mining and Metallurgy, 1968.

See CONF-680654.

A brief description is given of nuclear power reactors and their fuels. These fuels are made from a variety of uranium compounds such as uranium dioxide and uranium carbide as well as uranium metal and its alloys. The various processes used to produce some of these compounds from yellow cake are outlined. Using the natural uranium, heavy water reactor by way of illustration, fabrication of fuel elements is discussed and the characteristics of UO_2 powder required for this particular fabrication are indicated. The flowsheets and equipment presently in use overseas for production of this type of UO_2 powder are described. Possible areas where improvements might be made to this conventional process are enumerated and some details are then given of the program of work which has commenced at the A.A.E.C. Research Establishment to gain experience in the general field of nuclear grade UO_2. (auth) (Australia)

41714 INDUSTRIAL PRODUCTION OF NUCLEAR FUEL ELEMENTS. Demaret, E. (Metallurgie et Mecanique Nucleaires, Dessel, Belg.). Atompraxis, 15: 159-62(May-June 1969). (In French).

The manufacture of the nuclear fuel elements for PWR-Westinghouse type reactors, with sintered uranium oxide pellets, coated with stainless steel is briefly described. The numerous verifications and examinations needed to ensure the high quality of the product are emphasized as an important factor in the economy of the nuclear power plants. Methods are given that could also be used outside the nuclear industry field, such as the quality control of powders, the tube inspection by eddy currents and by ultrasonic waves, the tightness verification by helium test. A summary of the features of the nuclear fuel industry is given as a conclusion. (auth)

41715 FINISHING PROCESSES FOR OXIDE CERAMICS. Kirchner, H. P. (Ceramic Finishing Co., State College, Pa.). Sci. Advan. Mater. Process Eng. Proc., 14: Paper II-3A-1(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

Recent research resulted in new finishing processes for oxide ceramics. Starting with fired oxide bodies, these processes include methods of machining, strengthening, and joining. Leaching of alumina ceramics with hydrofluoric acid removes the intergranular material, weakens the bond between the grains, and renders the material machinable. In the leached condition, the material was machined by a variety of operations including drilling, internal and external threading, slotting, turning, and grinding. The material was refired to a relatively non-porous condition. The refired material has useable mechanical and dielectric properties. Formation of compressive surface layers was used to strengthen a wide variety of ceramic materials. Processes are available to strengthen sapphire crystals and polycrystalline alumina, zirconia, titania, spinel, magnesia, nickel oxide, steatite, forsterite, zircon porcelain, electrical porcelain, and other materials. Flexural strength increases of as much as 300% for sapphire single crystals and 100% for polycrystalline bodies were observed. In some cases, several different processes are available for strengthening a particular material. Tensile strength, thermal shock resistance and resistance to environmental degradation were improved. Chemical treatments were used to strengthen slip cast fused silica. Substantial increases in flexural strength were achieved. Compressive surface layers were effective in improving the quality of adhesive joints between ceramic parts. In some cases, the flexural strength of the joined ceramics exceeds that of comparable one-piece samples. This combination of new processes provides the means of fabricating ceramics in complex shapes and strong, reliable structures consisting of a number of joined ceramic pieces. (auth)

41716 THE CHARACTERISTICS OF THE Mg–B COMPOSITE SYSTEM. Cunningham, Andrew L.; Davies, Lawrence G.; Alexander, John A. (General Technologies Corp., Los Angeles). Sci. Advan. Mater. Process Eng. Proc., 14: Paper II-1B-2(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

Fabrication of uniaxial magnesium–boron composites by diffusion bonding and liquid-metal infiltration is discussed, with particular emphasis on minimization of property variations at high strength levels. The composites generated exhibit extraordinary strength-to-density ratios which significantly exceed current aerospace structural materials designed for use within the 25 to 500°C temperature regime. Mg–B composites maintain 67% of room temperature strength at 500°C. The achievement of predicted rule-of-mixtures strengths, as well as high strength retention at elevated temperatures is attributed to minimized filament degradation, achievement of a strong filament-matrix bond and the absence of reactivity of the components. (auth)

41717 IMPROVED PROCESS FOR MAKING PARTICLES. (to Gulf General Atomic Inc.). British Patent 1,161,243. Aug. 13, 1969. Priority date Oct. 5, 1965, United States.

A process is described for preparing spherical particles applicable to the production of reactor fuel. Sol droplets are injected into an upward flowing organic liquid in which they are suspended a sufficient time to gel. The colloidal sol can be an oxide of thorium and the organic liquid 2-ethyl-1-hexanol. (J.R.D.)

41718 HOT-PRESSING OF ZIRCONIUM DIBORIDE–LANTHANUM HEXABORIDE MIXTURES. Kinoshita, Makoto; Kose, Saburo (Government Industrial Research Inst., Osaka). Yogyo Kyokai Shi, 77: 200-7(June 1969). (In Japanese).

Powder mixtures of zirconium diboride and lanthanum hexaboride were hot-pressed at the temperatures ranging from 1700 to 2200°C in graphite mold under the pressure of 200 kg/cm^2. During hot-pressing at temperatures below 2000°C, shrinkage of the compact was measured by means of a dial gage which was connected with the ram table of the hot-press furnace. The ram table moved in relation to the densification of the compact at high temperatures. Final density was measured and density change of the compact during hot-pressing was calculated. Microstructures were observed using microscope and electron probe microanalyzer. Densification of zirconium boride compacts was accelerated by addition of 3 wt % lanthanum boride and the effect seemed to be mostly due to the increased densification of lanthanum boride. From the densification data, log $(1-\rho)$ was plotted against t according to Murray's equation and fairly good linearities were observed between them except the early period. The viscosities, η, of the compacts were calculated from the slopes of the plots. On the basis of their temperature dependences activation energies were observed to be 76 kcal/mol for zirconium boride compact, 68 kcal/mol for zirconium boride compact with 10 wt % lanthanum boride and 60 kcal/mol for lanthanum boride compact, respectively. Mutual penetration of Zr or La element to another boride particle was not detected. These compacts did not show good oxidation resistance. (auth) (NSA of Japan)

41719 REFRACTORY CONCRETES CONTAINING BARIUM CEMENTS. Budnikov, P. P.; Kulikova, N. V.; Savel'ev, V. G. (Moscow Inst. of Chemical Tech.). Izv. Vyssh. Uchev. Zaved., Khim. Khim. Tekhnol., 11: No. 2, 193-9(1968). (In Russian).

The most popular forms of binders for refractory concretes are portland cement with microfillers, aluminum silicate cement, and water glass and phosphate cements. The existing drawbacks of these materials necessitate research for more refractory and effective forms of binders to be used in refractory concretes. One of the forms of such binders is barium–aluminum oxide and barium silicate–aluminum oxide cement, in which the principal oxide is BaO. Results of a study of the properties of refractory cements composed of barium silicate–aluminum oxide and barium–aluminum oxide cement are presented. The investigated parameters of concrete included heat resistance of materials, deformation under 2 kg/cm^2 load at elevated temperatures, thermal expansion, heat shrinkage, compression and flexure strength, density, porosity and hygroscopicity. Standard test methods were used in the evaluation of these concretes. Investigations have shown that barium cement caused a relatively low decrease in the refractory properties of the filler. All of the investigated concretes are heat resistant up to 1710°C. The best properties were exhibited by barium–aluminum oxide cement. The heat resistance of these concretes was higher than those consisting of barium silicate–aluminum silicate cement. However, even the properties of the latter significantly exceed those of ordinary calcium cements. It is pointed out that barium cements are good shielding materials for ionizing radiation and are stable to attack by sea and sulfate water. The barium containing refractory concretes will expand the area of applicability of this new progressive form of concrete. (JPRS)

41720 PROCESS FOR PREPARING PLUTONIA AQUASOLS. Lloyd, M. H.; Haire, R. G. (to U. S. Atomic Energy Commission). U. S. Patent 3,461,076. Aug. 12, 1969.

An improved method for preparing plutonia aquasols consists of aging a washed alkaline precipitated plutonium(IV) hydroxide precipitate in an aqueous medium for a period of about 2 hr at 95°C prior to peptization. (AEC)

41721 INITIAL-STAGE SINTERING OF THE ACTIVE BeO POWDER. Suzuki, Hiroshige; Hattori, Takeo (Tokyo Inst. of Tech.). Yogyo Kyokai Shi, 77: 193-200(June 1969). (In Japanese).

Initial-stage sintering of the active BeO powder was investigated by measuring the isothermal shrinkage of its powder compacts continuously using thermo-dilatometer consisting of a linear variable differential transformer activating an X–Y recorder, in vacuum for the temperature range 1250 to 1450°C. It was found that initial-stage sintering of the active BeO powder is a rapid densification process represented by the straight line with a slope of unity, when logarithm shrinkage was plotted against logarithm time. Large amounts of the initial shrinkage for a short time period due to this process markedly shortened the time to complete the densification. The phenomenon showed characteristically one of many properties of the active BeO powder, which is considered to be sinterable. This process was followed by the neck growth due to vacancy-volume diffusion. (auth) (NSA of Japan)

41722 VIBRATION PRESSING OF CERAMIC POWDERS. McFetridge, D.; Byrne, J. (Morganite Research and Development Ltd., London). Proc. Brit. Ceramic Soc., No. 12, 165-78(Mar. 1969).

The design and construction of a press in which an oscillating load can be superimposed on the normal steady load is described. This equipment was used to prepare simple compacts in various dry granular materials. In general, it was observed that the static component required to produce a given degree of compaction was less than that required in simple pressing, and that hard granular particles responded better than smooth spherical particles. In the extreme case reductions in static pressure of the order of 90% were possible. Results are given for barium–titanate, clay–graphite mixtures, carbon and silicon carbide. (auth) (UK)

41723 NUCLEAR REACTOR FUEL. Robertson, John A. L. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,462,371. Filed Mar. 9, 1967.

A technique is described for converting a shaped ceramic nuclear fuel mass comprising a hyperstoichiometric dioxide of a metal selected from uranium, plutonium, thorium, and mixtures thereof to a hypostoichiometric state. The shaped mass is coated with a thin layer of carbon, then annealed at above about 1,500°C in vacuo or an inert gas atmosphere until the carbon coating has been substantially removed by reaction with the substrate, thereby producing the desired hypostoichiometric state. (Offic. Gaz.)

41724 FABRICATION OF DISPERSION-TYPE REACTOR FUEL CONSISTING OF UC AND SiC. Suzuki, Hiroshige; Matsunaga, Ichiro (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 90, 21-6(Mar. 1969).

The difficult fabrication of dense silicon carbide was accomplished by a reaction sintering method. The mechanism of the reaction is briefly discussed. Also, dense reactor fuels of UC dispersed in SiC matrix were satisfactorily fabricated. Irradiation tests are now being made on these specimens. (NSA of Japan)

Properties Evaluations

Refer also to abstracts 41615, 41618, 41626, 41638, 41715, 42476, and 43083.

41725 (ALO-2661-12) DEVELOPMENT OF 400 TO 1800F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Final Report. Collins, J. O.; Jaunarajs, K. L.; Reid, D. R. (Johns-Manville Research and Engineering Center, Manville, N. J.). [1969]. Contract AT(29-2)-2661. 236p. Dep. CFSTI.

An extensive evaluation of submicron particles other than silica was undertaken to provide for a MIN-K product with long term service capability to 2200°F. The mechanism of product failure at elevated temperatures was studied, and attempts were made to prevent or delay this failure. A high density MIN-K formulation was developed and evaluated for 1400°F service as a load-bearing insulation. The effects of product formulation on the thermal conductivity, modulus of elasticity, and load relaxation with time were the primary considerations. GLASROCK 25 foam silica, a relatively low density, low thermal conductivity, high strength refractory was studied with the intent of adding opacifiers for further thermal efficiency. The primary areas of investigation included the effects of the opacifiers on the manufacturing procedure, strength, and thermal conductivity. (auth)

41726 (BNWL-1101) COMPATIBILITY OF BOTH MIXED URANIUM-PLUTONIUM OXIDES AND NITRIDES WITH SODIUM AND 304-STAINLESS STEEL. Smith, F. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 30, 1969. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

Out-of-reactor experiments to determine the compatibility of mixed uranium-plutonium nitrides (UN-20 wt % PuN) and hypostoichiometric mixed oxides (UO_2-25 wt % PuO_2), both helium- and sodium-bonded, to Type 304-stainless steel cladding have been performed. Capsules were heated for periods as long as 5000 hours at temperatures of 650 and 1000°C. No reactions or corrosion layers were observed on adjacent fuel-clad surfaces in cases of both oxide and nitride fuels under the time-temperature conditions investigated. (auth)

41727 (LA-4165) MEASUREMENT OF PYROCARBON THERMAL CONDUCTIVITY BY THE FISSION COUPLE METHOD. Salgado, Peter G.; Schilling, Fred P.; Brock, Gerald T. (Los Alamos Scientific Lab., N. Mex.). Mar. 31, 1969. Contract W-7405-eng-36. 16p. Dep. CFSTI.

A technique for measuring the thermal conductivity of the pyrocarbon coatings of coated particle fuel is described. The nuclear fuel particles were overcoated with tungsten, and thermocouple wires were welded 180° apart to the tungsten. These intrinsic thermocouples (fission couples) were subjected to neutron bursts and the surface temperature responses were monitored. If particle dimensions and burst shape are known, the effective thermal conductivity of the pyrocarbon coats can be calculated. Experiments were conducted to measure the conductivity of a low-density pyrocarbon buffer coat. Comparisons were made between values obtained by the fission couple method and the xenon flash method for two dense pyrocarbons. A TRISO I particle was tested and the thermal conductivity of the buffer layer was estimated to be 0.0039 ± 0.0011 cal/cm-sec-°C. (auth)

41728 (WAPD-TM-751) THE HOT-PRESSING BEHAVIOR OF SINTERED LOW-DENSITY PELLETS OF UO_2, ZrO_2-UO_2, ThO_2, AND ThO_2-UO_2. LWBR Development Program. Kaufman, S. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1969. Contract AT(11-1)-Gen-14. 48p. Dep. CFSTI.

The out-of-pile hot-pressing behavior of sintered low-density oxide fuel pellets of UO_2, ZrO_2-UO_2, ThO_2, and ThO_2-UO_2 was investigated over a temperature range of 1600 to 2150°C to obtain supplemental creep data for use in predicting the pore closure rates during irradiation. The results obtained correlated well with results of out-of-pile compression creep tests performed on dense pellets. For the UO_2-ZrO_2 compositions, strain rates computed from porosity changes varied linearly with the applied stress and agreed with compression creep data within a factor of three. Test results on UO_2 were limited, but more extensive results on ThO_2 and ThO_2-UO_2 compositions showed a transitional, stress-dependent behavior in agreement with compression creep data. Quantitatively, the hot-pressing data for ThO_2-UO_2 compositions did not agree with compression creep data as well as the hot-pressing data for the UO_2-ZrO_2 compositions and were generally much lower at higher temperatures. Changes in stoichiometry to a hypostoichiometric state resulting from use of the carbonaceous atmosphere are believed to be responsible for the lower observed creep rates. (auth)

41729 INTERACTION OF OXIDES OF RARE EARTH ELEMENTS WITH THE OXIDE OF SODIUM. Spitsyn, V. I.; Murav'eva, I. A.; Kovba, L. M.; Korchak, I. I. Zh. Neorg. Khim., 14: 1451-5(June 1969). (In Russian).

Studies were made of compounds of the general order $NaLnO_2$ to obtain information on the structure and composition of these compounds and on the change in structure in relation to the ratio of atomic radii. (tr-auth)

41730 MECHANICAL PROPERTIES OF A BORON AND TUNGSTEN CARBIDE SINTERED MATERIAL. Bollani, G. Met. Ital., 61: 181-94(May 1969). (In Italian).

The test material was characterized through physical and chemical determinations, and mechanical properties at ambient temperature such as static ultimate stress, modulus of elasticity, impact strength, and fatigue strength were assessed. The static compressive ultimate stress was determined also at 700, 1200, and 1400°C. Owing to material brittleness, a special test technique was required. The investigation was completed after microfractographic observations and the evaluation of the effects of test specimen roughness, notch, and size. Tungsten distribution factors were also considered. (J.R.D.)

41731 DYNAMIC ELECTRON MICROSCOPY OF HIGH TEMPERATURE REACTIONS. Mayhan, S. J.; Daniel, J. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Sci. Advan. Mater. Process Eng. Proc., 14: Paper I-1-3(1968).

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla. See CONF-681126.

Discussion is presented on special techniques and accessories developed for electron microscopy that allow continuous observation and recording of dynamic reactions occurring in high temperature materials. Bulk specimens may be heated to over 2000°C, in vacuum or low pressure gas atmospheres simulating actual working conditions. Time-lapse cinemicrography provides a particularly valuable record of subtle or rapid reactions for study and evaluation. (auth)

41732 THE LINEAR EXPANSION AT UP TO 1100^{0}C AND THE DENSITY OF SOME ALLOYS AND COMPOUNDS OF URANIUM. Mochalov, G. A.; Tagirova, R. Kh.; Terekhov, G. I.; Ivanov, O. S. pp 53-62 of Fiz.-Khimiya Splavov i Tugoplavkikh Soedin. s Toriem i Uranom. Moscow, Nauka, 1968. (In Russian).

The coefficient of linear expansion at up to 1100°C was determined for UC, UO_2, UBe_{13}, UAl_2, USi_2, $BaUO_4$, $CaUO_4$, Ca_3UO_6, and $SrUO_6$ and for binary and ternary alloys of U with Mo, Zr, and Nb. The measurements were made in a quartz dilatometer in vacuum (air for the mono and ortho uranates because of their high resistance to oxidation). Curves are given for relative expansion against temperature. Results are also given of room-temperature determinations of the density of specimens of U; U-Zr, U-Nb, and U-Mo alloys; and compounds of U with Be, C, O, Al, Si and also Nb and V. (Referativnyi Zh.)

41733 SOME FACTORS AFFECTING THE DIFFUSION OF ACTINIDE ELEMENTS IN UO_2. Furuya, Hirotaka. Sci. Rep. Res. Inst., Tohoku Univ., Ser. A, 20: 167-75(Mar. 1969).

In connection with the influences of the densification of sample, the evaporation of diffusant during diffusion annealing and the grain size of starting material on the diffusion of actinide elements in UO_2, three types of experiment were performed by the sectioning method using ^{237}U and ^{233}Pa as tracers. In all cases, the logarithm of the concentration in a deeper region varied linearly with penetration depth, as is characteristic of grain-boundary diffusion. Near the surface, the lattice diffusion or the evaporation made a considerable contribution to the concentration, thus showing a nonlinear concentration profile. The extent of this deviation increased with the increases of initial density of the pellet and of grain size of starting material. The concentration near the surface decreased with the approach to it in the presence of evaporation. (auth)

41734 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 12: 171-6(Fall 1969).

Research and development results are summarized on graphite, Be metal and alloys, Zr hydrides, hydrided Zircaloys, and nuclear poisons. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 41650, 41667, and 41733.

41735 (BNWL-tr-30) THE CHEMISTRY OF PROMETHIUM. THE POLYMORPHISM OF PROMETHIUM(III) OXIDES. Weigel, F.; Scherer, V. Translated by Diana L. Davis (Battelle-Northwest, Richland, Wash.), from Radiochim. Acta, 4: 197-203(1965). 8p. Dep. CFSTI.

An investigation was carried out to determine if promethium oxide exists in three possible modifications: a hexagonal stratified lattice corresponding to the point group $P_{\bar{3}m}1$-D^{3}_{3d}, a complex monoclinic lattice, or the Mn_2O_3 type derived from a fluorite lattice in which two of the eight possible anion locations are vacant. All three modifications were observed. The first was blue-violet, the second red-violet, and the third coral red. The lattice unit volumes obeyed the lanthanide contraction for all three modifications. (M.C.G.)

41736 (ORNL-tr-2175) HYDROGEN IN METALS AS AN EXAMPLE OF A LATTICE GAS WITH PHASE TRANSITIONS: STATIC AND DYNAMIC CRITICAL PHENOMENA. Alefeld, G. (Kernforschungsanlage, Juelich (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report JUL-561-FN. 36p. Dep. CFSTI.

Metal-hydrogen systems offer a series of experimentally attractive groups of problems in connection with the structure, the states of mobility, and the critical phenomena of a lattice gas or a lattice liquid. In these systems in particular it should be possible to advantageously combine microscopic investigation methods, such as the relaxation and resistance measurements, or using microscopic methods such as neutron scattering or nuclear resonance. Phase diagrams and solubility measurements are discussed on the basis of which conclusions were drawn regarding the existence of liquid-like phases in a solid body. The similarity between the lattice gas and a free gas is emphasized, however the essential differences between lattice gas and free gas are discussed. The extent of the quantum effects corresponding to the statistics involved at low temperatures is discussed in the case of lattice liquids such as hydrogen, deuterium, and tritium. (J.R.D.)

41737 MASSIVELY DEFECTIVE CRYSTALLINE SOLUTIONS IN FLUORITE-STRUCTURE OXIDES: THE SYSTEMS $ThO_2-Ln_2O_3$ ($Ln = La^{3+}$, Gd^{3+}, Yb^{3+}). Diness, A. M. (Office of Naval Research, Washington, D.C.); Roy, Rustum. J. Mater. Sci., 4: 613-24(July 1969).

Subsolidus phase relations were defined in three representative rare earth sesquioxide (La_2O_3, Gd_2O_3, Yb_2O_3)-thoria systems over a wide range of compositions by x-ray methods (from phase detection and precision lattice parameter measurements). Characterization of the point defects in these fluorite structure materials shows good agreement between calculated anion vacancy models and measured density values. Currently accepted crystal chemical generalizations were found to be inadequate to rationalize phase equilibria and crystalline solubility limits in these systems. (auth) (UK)

41738 ROUTINE METHOD OF CRYSTALLITE SIZE (L_a) DETERMINATION OF PYROLYTIC GRAPHITE. Hirai, T. (Tohoku Univ., Sendai). J. Mater. Sci., 4: 644-6(July 1969).

For most graphite materials the powder method is generally adopted for x-ray-diffraction study of their crystal structures. Powdered samples of pyrolytic graphite, however, show a considerable degree of preferred crystallite orientation when mounted in a sample holder, making it impossible to obtain a complete powder diffraction pattern. The use of the transmission method is necessary to obtain the (11.0) line of pyrolytic graphite in bulk form, because a specimen sufficiently thick for the reflection method cannot always be easily prepared in an experimental apparatus. In the transmission method, since the measured width of the (11.0) line is considerably affected by the specimen thickness, it is very important to compare the line-width obtained by the transmission method with that obtained by the reflection method. Guentert (J. Chem. Phys. 37: 884(1962)) examined the crystallite size (L_a) in the a-direction of pyrolytic graphite by means of a Fourier analysis of the profile of the (10) and (11) bands which were obtained by the transmission method from a 1 mm thick specimen, and pointed out that the determination of L_a was not complicated by strain in the pyrolytic graphite, and that the correction for instrumental broadening was important. Guentert's method is accurate but the performance of such analysis is rather tedious and time-consuming when applied to a large quantity of samples. The purpose of the experimental work described is to replace Guentert's method with a quick routine method suitable for quality control. (auth) (UK)

41739 CHANGES IN THE ZrO_2 STRUCTURE AT HIGH-TEMPERATURES IN VACUUM. Andreeva, N. A.; Gropyanov, V. M.; Kozlovskii, L. V. (Leningrad Technological Inst.). Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 1302-3(July 1969). (In Russian).

Tests made with monoclinic ZrO_2 containing 99.986 wt % ZrO_2 with specific surface of 10 m^2/g showed that in high-temperature vacuum annealing (starting from 2000°K) ZrO_2 changed its color from white to dark gray due to the loss of oxygen in the anion sublattice. At 2750°K ZrO_2 exhibited its behavior by changing from monoclinic structure to tetragonal with the spectrum adding two additional bonds 1180 and 1100 cm^{-1}. (R.V.J.)

41740 GADOLINIUM-HYDROGEN SYSTEM AT ELEVATED TEMPERATURES. VACANCY INTERACTIONS IN GADOLINIUM DIHYDRIDE. Libowitz, G. G.; Pack, J. G. (Kennecott Copper Corp., Lexington, Mass.). J. Phys. Chem., 73: 2352-6(July 1969).

Pressure-composition-temperature measurements were performed on the gadolinium-hydrogen system at 800, 850, and 900°C. The equilibrium hydrogen pressures and phase boundaries obtained were in agreement with extrapolations from previous work below 800°C. The metal-rich phase boundary of gadolinium dihydride was found to occur at H/Gd values of 1.71, 1.56, and 1.4 at 800, 850, and 900°C, respectively. The large number of experimental points in the hydrogen-deficient single-phase region of gadolinium dihydride permitted further verification of previously derived thermodynamic activity relationships assuming interaction between defects in nonstoichiometric compounds. The existence of hydrogen vacancies in gadolinium dihydride was corroborated, and the free energy of interaction between hydrogen vacancies was found to be 2 kcal/mol. (auth)

41741 OVERPOTENTIALS FOR INTERCALATION INTO GRAPHITE. Ubbelohde, A. R. (Imperial Coll. of Science and Tech., London). Nature (London), 223: 495-6(Aug. 2, 1969).

Before intercalation of other molecules between the carbon hexagon networks in graphite can commence, the molecules must be given a sufficient chemical or electrical overpotential. This excess potential depends sensitively on the textural perfection of the graphite, and measurements of overpotential afford a valuable diagnostic test for near ideal graphites. In general, graphites of the highest perfection require the lowest overpotentials for intercalation of a particular molecular species. It was also found that with near ideal graphites the overpotential is very sensitive to neutron irradiation; doses as low as 3×10^{14} n/cm^2 make intercalation more difficult. The irradiation appears to pin the dislocations, whose sweep through the graphite crystallites must accompany intercalation in any crystal layer. Possible technological applications of the effect can be envisaged, particularly with regard to chemical and electrochemical attack. The effect has certain analogies with the irradiation cross-linking of polymers, although the detail mechanisms are quite different. (UK)

41742 METALLOGRAPHIC EVIDENCE OF THE EXISTENCE OF A CONTINUOUS-OXIDE PHASE IN SAP-865. Meyers, C. L. Jr. (Argonne National Lab., Idaho Falls, Idaho); Stulpe, K. Metallography, 2: 41-56(Mar. 1969).

The nature of the microstructure of sintered aluminum powder (SAP) has been the subject of speculation and controversy since its initial development. The dispersed-particle theory (discrete alumina particles dispersed in an aluminum matrix) has been a widely accepted explanation of this system. It is shown that the dispersed-particle theory does not apply to SAP-865. Metallographic evidence is presented to show that the system contains a continuous, rather than a dispersed, oxide phase. The metallographic analysis of extruded rods, both as-received and after annealing at 690°C, is integrated with previously published work on the mechanical behavior of this material. (auth)

41743 MICROSTRUCTURE OF ZIRCONIUM-BASED TERNARY CARBIDE ALLOYS. Carnahan, R. D.; Janowski, K. R.; Rossi, R. C. (Aerospace Corp., El Segundo, Calif.). Metallography, 2: 65-77(Mar. 1969).

The microstructures of the zirconium carbide-graphite alloys were characterized, and the effect of ternary additions on the microstructure of a high-carbon base alloy was studied. Minor variations of carbon content in the vicinity of the eutectic composition produced gross microstructural changes. The addition of boron produced a coarsening of the microstructure, and the combined addition of magnesium and silicon produced graphite nodules. The addition of tantalum carbide caused major alterations of the microstructure with the complete loss of characteristic features at high additive concentrations. (auth)

41744 FORMATION ENERGY OF A VACANCY IN GRAPHITE. Mayer, Rayner M. (Cambridge Univ., Eng.). Carbon, 7: 512-13(Aug. 1969).

Theoretical values for the formation energy are shown to agree with those recently determined experimentally, if a suitable figure is chosen for Van der Waal's bonding E_c between carbon atoms in adjacent layer planes. Comparison is made with Coulson's calculations [NSA 17: 34507]. (UK)

41745 DISCUSSION OF GRAIN GROWTH AND RECRYSTALLIZATION IN THORIA-DISPERSED NICKEL AND NICHROME. Tiwari, G. P. (Bhabha Atomic Research Centre, Bombay). Trans. Met. Soc. AIME, 245: 1658-9(July 1969).

An explanation of the effects of voids on recrystallization in these materials is presented. Information is presented to show that a decrease in supply of vacancies in creep is insufficient to adversely affect recrystallization due to low void population. (J.R.D.)

41746 MECHANISM OF PLASTIC DEFORMATION AND DISLOCATION DAMPING OF CEMENTED CARBIDES. Doi, H. (Mitsubishi Metal Mining Co., Ltd., Omiya City, Japan); Fujiwara, Y.; Miyake, K. Trans. Met. Soc. AIME, 245: 1457-70 (July 1969).

In order to throw light on the mechanism of plastic deformation of WC-Co alloys, compressive tests of WC-(7 to 43) vol % Co alloys have been carried out at room temperature, and stress-microstrain relation has been investigated. The analysis of the factors affecting the yield stresses reveals that they can be predicted by modified Orowan's theory if the planar interparticle spacings are properly estimated. Compressive straining of some of the alloys by 0.066 to 0.17% increases the decrements by a factor of as much as 3.4 to 14, whereas the corresponding increase in the electrical resistivities is less than 10%. The analysis of the decrement data in terms of Granato and Lücke theory shows that the marked increase is attributed to increased dislocation damping in the binder (cobalt) phase. By combining the decrement data and the compression data, the relation between flow stress in shear ($\Delta\tau$) and increase in dislocation density (ρ): $\Delta\tau = \text{const} \cdot \sqrt{\rho}$ is obtained. This is interpreted to mean that the mechanism of strain hardening of WC-Co alloys is essentially the same as the one for dispersion strengthened alloys. The possible effect of bridge formations between the carbide particles has also been examined. (auth)

41747 MELT DIAGRAMS OF MAGNESIUM AND URANIUM CHLORIDES. Desyatnik, V. N.; Izmodenov, Yu. A.; Mel'nikov, Yu. T.; Nichkov, I. F.; Raspopin, S. P. At. Energ. (USSR), 26: 549-50(June 1969). (In Russian).

Melt diagrams of UCl_3-UCl_4 and $MgCl_2-UCl_3-UCl_4$ were analyzed by differential thermal analysis method using an NTR-62M recording device. The initial chloride ratios of chlorine to magnesium or uranium were 1.97, 4.01, and 3.02 and had melting temperatures of 718 ± 2, 585 ± 2, and 836 ± 2°C, respectively. The ternary eutectic containing 18 mole % MgCl, 10 mole % UCl_3 and 72 mole % UCl_4 melted at 520°C. Diagrams of polythermal cross sections of the system are included. (R.V.J.)

41748 GRAIN GROWTH OF ZIRCONIUM DIBORIDE. Kinoshita, Makoto; Kose, Saburo (Government Industrial Research Inst., Osaka). Yogyo Kyokai Shi, 77: 255-63(Aug. 1969). (In Japanese).

Hot-pressed zirconium diboride compacts which had four kinds of relative densities were heated in graphite at temperatures ranging from 1400 to 2500°C. The surfaces of the heated compacts and their textures were examined by x-ray diffraction and optical microscope. Weight and relative density as well as average grain size of each compact were then measured. Through heating at the lower temperatures, ZrO_2 appeared on the surface of the compacts and then changed to ZrC at temperatures between 1700 and 1800°C. Lattice constants of ZrC changed to the normal values from the smaller ones with increasing temperatures. From this fact, it was supposed that ZrN was also formed simultaneously in this temperature range and made solid-solution with ZrC. While oriented graphite layers covered the surfaces of the compacts heated at temperatures above 2400°C, thin films of graphite were observed over the molten surfaces of the compacts heated at 2500°C. Relative density of each compact reached about 0.97 when it was heated at 2500°C for 100 min. Data on grain growth were processed under the application of the equation $D^2 - D_0^2 = kt^m$, the value of m being either 0.66 ~ 0.78 or about 1 for heating temperatures of 2100 ~ 2300 or 2400°C. When the compact was heated at 2300°C, grain growth was rapid at the surface layer compared with the inner part and the m reached about 1 at this layer. Grain growth rate constant, k is the above equation increased with increase in the initial densities of the compacts. But the same temperature dependence was obtained for all the compacts heated at the temperatures between 2100 and 2300°C. The activation energy in the process of grain growth was calculated to be about 60 kcal/mol. (auth) (NSA of Japan)

41749 $CdO-MoO_3$ SYSTEM. Zobnina, A. N.; Kislyakov, I. P. (Moscow Inst. of Fine Chemical Tech.). Neorg. Mater., 5: 1472-3(Aug. 1969). (In Russian).

Differential thermal analyses of $CdO-CdMoO_4$ and $CdMoO_4-MoO_3$ sections of the $CdO-MoO_3$ systems showed that the $CdMoO_4-MoO_3$ system is of the eutectic type with 86.7 mole % MoO_3 eutectic composition and a melting point of 688 ± 6°C. The system was prepared by precipitation from solution and annealing at 900°C. (R.V.J.)

41750 ANALYSIS OF W-Co-Si AND W-Ni-Si SYSTEMS. Skolozdra, R. V.; Shipka, Z. P.; Gladyshevskii, E. I. (Lvov State Univ.). Neorg. Mater., 5: 1466-8(Aug. 1969). (In Russian).

Phase equilibria and composition of compounds with $MgZn_2$ structure in ternary W-Co-Si and W-Ni-Si systems were studied. The W-Co-Si specimens were annealed at 1000°C for 500 hr and the W-Ni-Si specimens at 800°C for 1000 hr. Graphical data are given for isothermal cross sections and λ-phase lattices. (R.V.J.)

Radiation Effects

Refer also to abstracts 41680, 41681, 41741, and 42438.

41751 (GEAP-5633) COMPATIBILITY OF URANIA-PLUTONIA FUELS WITH STAINLESS STEEL AND SODIUM. Lauritzen, T. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). June 1968. Contract AT(04-3)-189. 53p. Dep. CFSTI.

The elevated temperature compatibility of mixed plutonia-urania fuels with austenitic stainless steel cladding was evaluated. The results of both out-of-pile and in-pile tests are summarized. The austenitic alloys 304, 316, 321, 347, and Incoloy 800 were observed to be fully compatible with stoichiometric and slightly substoichiometric fuel for durations of at least 1000 hours at 1400°F in out-of-pile inert atmosphere systems as well as in systems containing sodium vapor. All alloys exhibited slight incompatibility with hyperstoichiometric fuel in similar environmental systems. Incompatibility was manifested primarily in cladding surface oxidation with reaction zones ranging in depth from trace quantities in Incoloy 800 to 35 microns in Type 347. Although several types of reaction were observed in irradiated fuel pin cladding, none could be attributed to incompatibility between fuel and cladding alone. The most common effect noted was the heavy grain boundary precipitation along the inner surface of the cladding, which was attributed to the thermal migration of carbon. Instances in which cladding was observed to have been severely attacked were related in most cases to tests that had experienced overpower conditions, resulting in excessively high interface temperatures. (auth)

41752 (GEAP-5761) THE IRRADIATION OF URANIA-PLUTONIA FUEL TO 125,000 MWd/Te IN A THERMAL FLUX. Rubin, B. F.; Perry, K. J. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Mar. 1969. Contract AT(04-3)-189. 44p. Dep. CFSTI.

Pins containing mixed oxide fuel in the stoichiometric and hypostoichiometric states were irradiated to 125,000 MWd/t in a thermal flux in order to compare their irradiation performance. No significant differences were observed in regards to microstructure, dimensional change ($<0.1\%$ ΔD for both pins), and gas release (~80% of theoretical for both pins). X-ray diffraction patterns of the highly burned up fuel showed that crystallinity was retained, and that differences in stoichiometry, as indicated by differences in unit cell size, persisted at high burnup. The cell sizes of both fuels were smaller than pre-irradiation values, probably due to the inclusion of zirconium and rare earth fission products within the lattice. (auth)

41753 TEST OF MOLYBDENUM DISULFIDE LUBRICANTS IN RADIATION AND VACUUM ENVIRONMENTS. Lewis, J. H.; McDaniel, R. H. (General Dynamics, Fort Worth, Tex.). J. Lubric. Technol., 91: 390-6(July 1969).

Tests have been conducted on two MoS_2-base solid-film lubricants, one containing gold and sodium silicate and the other containing bismuth and aluminum phosphate, having potential for application under severe environmental conditions. The lubricant with gold was applied to test races of 440 C steel and René 41 and exposed with a reactor to 1.5×10^{11} ergs/g (C) of gamma and 8.2×10^{16} neutrons/cm^2 ($E > 0.1$ MeV). The test specimens were subsequently evaluated in sliding-wear tests at temperatures as high as 1200°F. Both lubricants were tested in vacuum (~10^{-6} torr) and in air on size R-3 ball bearings, which were run at 6000 rpm in servomotors. No significant radiation effects were detected with the MoS_2 : Au lubricant on 440 C steel in tests at room temperature and 600°F. In tests at room temperature, 600 and 1200°F on René 41, the data indicated a possible radiation effect at 600°F but not at the other temperatures. In two vacuum tests on bearings, the MoS_2 : Au lubricant gave a mean running time of about 110 hr. The MoS_2 : Bi film gave a mean life of 96 hr in the first test and 853 hr in the second test. (auth)

41754 ADSORPTION OF PHOSPHATES ON ALUMINA IRRADIATED BY NEUTRONS AND γ RAYS. Jacimovic, Lj.; Veljkovic, S.; Ajdacic, N. (Boris Kidric Inst., Belgrade). Radiochim. Acta, 12: 49-50(July 1969).

The effects of reactor irradiation on aluminum oxide surfaces were studied by adsorption experiments carried out in aqueous solutions of Na_2HPO_4 labeled with ^{32}P. Adsorption isotherms of irradiated and nonirradiated samples are tabulated. Post-irradiation annealing of the samples was found to increase the adsorption capacity for phosphates. (J.G.B.)

41755 TRANSIENT EFFECTS OF NUCLEAR RADIATION ON THE DIELECTRIC PROPERTIES OF REFRACTORY LOW-LOSS CERAMICS AT MICROWAVE FREQUENCIES. Edelson, D.; Jaeger, R. E.; Williams, J. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Amer. Ceram. Soc., 52: 359-63(July 21, 1969).

Selected ceramic materials were exposed to an intense burst of nuclear radiation to determine the transient effects of such an environment on their dielectric properties at frequencies in the L, S, and X bands. The radiation source was a pulse reactor of the swimming pool type which delivers a maximum dose of 2×10^{14} n/cm^2 and 5×10^5 rd gamma during a 13 msec pulse. The dielectric constant and loss of the materials under test were measured before, during, and after irradiation using a resonant cavity technique successfully adapted to the unusual conditions of the experiment. The time resolution in the dielectric measurements was 10 msec. Results are reported for polycrystalline alumina, beryllia, magnesia, boron nitride, clear and opaque fused silica, and, for comparison, four organic dielectrics. Among the materials which exhibited radiation effects, changes in dielectric constant ranged from 0.001 to 0.008 and in tan δ from a factor of 2 to several orders of magnitude. (auth)

41756 IRRADIATION TESTING (PULSE CONDITIONS) OF THE TERNARY FUEL SYSTEM FOR THE POWER BURST FACILITY. Beals, R. J. (Argonne National Lab., Ill.); Kern, R. S. J. Amer. Ceram. Soc., 52: 355-8(July 21, 1969).

The Power Burst Facility (PBF) is a flexible, pulse-type nuclear reactor constructed to provide high thermal neutron fluxes during short period power excursions. The PBF reactor core is composed of a fuel in the system UO_2-ZrO_2-CaO. The performance requirements imposed on this fuel necessitated a testing program to establish out-of-pile and in-pile characteristics of the fuel. In-pile test results obtained under pulse conditions, and out-of-pile results on selected fuel compositions to verify phase and volume stability of the ternary fuel are presented. Compositions of 16 and 35 mol % urania were investigated at 2000 to 2700°C in-pile. (auth)

41757 INTERSTITIAL ATOM ENERGIES IN GRAPHITE. Thrower, P. A.; Loader, R. T. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 7: 467-77(Aug. 1969).

A theoretical analysis of the free interstitial in graphite was made using various atomic interaction potential functions with a view to reconciling experimental and theoretical values for interstitial formation and basal-plane migration energies. Earlier calculations of Coulson et al. [NSA 20: 29735], are shown to contain extrapolation errors, and the largest obtainable value of the migration energy is shown to be around 0.03 eV. This result is discussed with reference to recently published experimental data on the annealing behavior of stored energy and thermal resistivity in graphite irradiated at low temperatures, and it is concluded that impurity trapping of point defects in graphite is of importance for quite low impurity concentrations at these temperatures. (auth) (UK)

41758 CONSTANT STRESS IRRADIATION CREEP EXPERIMENTS ON GRAPHITE IN BR-2. Brocklehurst, J. E.; Brown, R. G. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Carbon, 7: 487-97(Aug. 1969).

The irradiation induced creep of near-isotropic polycrystalline graphites under constant tensile and compressive stresses in the reactor BR-2 is considered. It is shown that up to a fast neutron dose of 50×10^{20} n.cm^{-2} there is no large effect of irradiation temperature on creep strain between 300° and 650°C, and the increase in creep strain with dose at constant stress is similar in compression and tension up to 1% creep strain. Comparison of the results with those on anisotropic materials shows a correlation of creep and elastic strain, which suggests creep deformations are also controlled by crystal shear. The thermal expansion coefficient of graphite is significantly affected in opposite directions by compressive and tensile creep, but Young's modulus is not affected by creep strain. Changes in dimensions and thermal expansion coefficient of tensile and compressive creep specimens and their controls during thermal annealing experiments are described. These show a large apparent recovery in creep strain which is not observed in irradiation annealing experiments. Possible interpretations of the results are discussed. (auth) (UK)

41759 THE IRRADIATION PERFORMANCE OF URANIUM-PLUTONIUM OXIDE FUEL PINS. Cox, C. M. Nucl. Safety, 10: 380-91(Sept.-Oct. 1969).

The irradiation performance of (U,Pu)O_2 fuel pins with respect to swelling and fission-gas release, fuel cladding compatibility, and performance during transients is being studied. Both thermal and fast-flux irradiation data indicate higher fission-gas release from powdered fuels than from pellet fuels. Fast reactor irradiations to 7% FIMA [fissions per initial metal atom (U + Pu)] show no significant variations in cladding diametral increase as a function of smear density or void deployment in the smear-density range 75 to 90% theoretical. Hypostoichiometric helium-bonded (U,Pu)O_2 is apparently compatible with stainless-steel cladding for cladding inside temperatures to at least 600°C and fuel burnups to at least 10% FIMA. Failures resulting from severe transients can be expected to occur by melting of the cladding if the fuel burnup is low; however, after burnups of several percent, a pressure pulse due to release of entrapped fission gases upon fuel melting may lower the failure threshold. (auth)

Plastics and Other Materials

Refer also to abstracts 40731, 40967, 41613, 41692, 41725, and 41755.

41760 (N-69-24925) IN SITU ELECTRON, PROTON, AND ULTRAVIOLET RADIATION EFFECTS ON THERMAL CONTROL COATINGS. Final Report. Fogdall, Lawrence B.; Cannaday, Sheridan S.; Brown, Richard R. (Boeing Co., Seattle, Wash. Aerospace Group). [1968]. Contract NAS5-9650. 48p. (NASA-CR-100840; D-2-84118-9). CFSTI.

Electron, proton, and ultraviolet radiation exposures were conducted on 21 types of thermal control coatings. Measurements of spectral reflectance in the wavelength region from 240 to 2500 millimicrons were obtained in situ on a total of about 200 samples before exposures began, periodically during exposures, and both in vacuum and in air following exposures. Data obtained from these measurements were analyzed for spectral reflectance changes, for solar absorptance changes, for irradiation rate effects, and for synergistic effects. (auth) (STAR)

41761 (N-69-25406) PROTON BOMBARDMENT-INDUCED TARGET TEMPERATURES AND THERMAL ACCOMMODATION COEFFICIENTS OF ROCK POWDERS: MEASUREMENTS BY INFRARED PYROMETRY. Nash, D. B. (Jet Propulsion Lab., Pasadena, Calif.). Feb. 15, 1969. Contract NAS7-100. 22p. (NASA-CR-100922; JPL-TM-33-413). CFSTI.

Temperatures, measured as a function of bombardment time, proton power, rock composition, and target surface geometry, show that powder surfaces heat up rapidly under beams with powers greater than 0.1 W/cm^2 (e.g., 4 keV, 25 μA/cm^2); loosely packed or fine-grained powders heat up more rapidly and attain higher equilibrium temperatures than tightly packed or coarse-grained powders. Comparative subsurface temperatures obtained with a buried thermocouple show thermocouples to be poor indicators of beam-induced surface temperatures of powders; this results from the low thermal conductivity of powders in vacuum and the consequent steep temperature gradient between the surface and the buried thermocouple. Values for the thermal accommodation (energy transfer) coefficients for 2 to 16 keV protons incident on basalt powder are calculated from the temperature data and found to range from 0.3 to 0.99, increasing in value with increasing proton energy and target surface temperature. (auth) (STAR)

41762 (NVO-38-18) AN EVALUATION OF "TUF" CONCRETE MADE WITH LONE STAR CEMENT. Vesper, Russell L. (Fenix and Scisson, Inc., Las Vegas, Nev. Fenix and Scisson, Inc., Tulsa, Okla. Petroleum Consultants, Houston, Tex.). May 1969. Contract AT(26-1)-38. 52p. Dep. CFSTI.

A field test was conducted to determine the properties of "Tuf" concrete made with a recently developed cement. It was found that "Tuf" concrete made with the tested formula can be used as structural material for emplacement room liners. "Tuf" concrete made with the new Lone Star cement as compared to that previously tested has a markedly increased compressive strength, does not have a significantly increased tensile strength, and has a substantially greater heat of hydration which contributes to more shrinkage. The uppermost core samples demonstrated consistently high compressive strengths but no general conclusion can be reached in regard to the effect of depth of sample on the compressive strength. "Tuf" fibers tend to segregate in larger concrete masses. However, the absence or presence of "Tuf" fiber in a specimen does not appear to affect the compressive strength. "Tuf" concrete does not initially set until approximately 2 hours after mixing, but a crust forms on the surface very rapidly if the material is allowed to come to rest. This results in the requirement of continuous movement or agitation to preserve the fluidity of the mix. No evidence was gained to indicate that complete water immersion of the concrete affects the properties. Frequent fluid density determination during mixing and placement is an effective quality control technique. The concrete does not significantly increase in strength after 7 days of moist curing. (auth)

41763 PROCESS FOR MAKING STRUCTURAL GYPSUM BOARD FOR NEUTRON SHIELDING. Darling, Arthur H.;

Weightman, Howard L. (to Kaiser Gypsum Company, Inc.).
U. S. Patent 3,453,160. Filed Nov. 12, 1963.

A method is described for forming a paper-lined board adapted to resist passage of neutrons impinging on its surface and containing as its major portion a mass of set gypsum crystals. The material for the board is formed by calcining raw gypsum rock containing calcium carbonate to form calcium sulfate hemihydrate and mixing the calcined material intimately with from 4 to 10% boric acid expressed as B_2O_3 and based on the total weight of boric acid plus the gypsum crystals. A previously mixed amount of NH_3 and H_2O is added to the solid mixture to prevent evolution of gas and to form a plastic slurry having a pH of from 6.0 to 7.5. This slurry is deposited between a pair of paper liners, and the board is formed by hardening and drying. (Offic. Gaz.)

41764 A STUDY ON THE EFFECTS OF RADIOACTIVITY ON ADHESION AND WELDING OF SOLID HIGH POLYMER. Kimura, Hiroshi; Uematu, Masakazu (Ehime Univ., Matsuyama, Japan). Ehime Daigaku Kiyo, Dai-3-Bu, Kogaku, 6: No. 2, 45-54 (Jan. 1969).

The irradiation conditions to activate the surface of polyethylene were studied with regard to the atmospheric temperature and irradiation time. The irradiation was carried out by pneumatic carrier No. 16 of JRR-1 with neutron flux of 3×10^{11} n/cm^2 sec. ^{60}Co γ-irradiation was also applied in oxygen gas. Polyethylene specimens irradiated under various conditions were subjected to heating plate weld, and their weldability examined by tensile testing means of autographs IM-500 of Instron type testing machine. The adhesive property of irradiated polyethylene was estimated by shearing test with the same machine taking account of surface treatment effects. It was found that the weldability is improved as the neutron irradiation dose increases. The effect of atmospheric temperature is insignificant. The cross-linking effect caused by irradiation increases tensile strength in relation with the increase of dose. The resistance to stress cracking was also improved by irradiation. γ-irradiation induces partial oxidation of polyethylene which will have a favorable effect on the weldability. The partial oxidation by irradiation had very little effect on the adhesive property. (NSA of Japan)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 40857.

41765 ASTROPHYSICS. Tayler, R. J.; Davidson, W.; Narlikar, J. V.; Ruderman, M. A. Progress in Physics Series. A Reprint Series. New York, W. A. Benjamin, Inc., 1969. 209p. $12.50 cloth; $4.95 paper.

Three papers are contained in this volume which were originally published in Reports on Progress in Physics. The papers are The Origin of the Elements (Tayler), Cosmological Models and their Observational Validation (Davidson and Narlikar), and Astrophysical Neutrinos (Ruderman). The authors were permitted to update their papers in a short addenda. (W.D.M.)

41766 DEVELOPMENT OF TURBULENCE IN A CONDUCTING FLUID. Ponomarenko, Yu. B. Sov. Astron. AJ (Engl. Transl.), 13: 86-90(July-Aug. 1969).

Translated from Astron. Zh., 46: 117-22(Jan.-Feb. 1969).

A discussion is given of the development of turbulence in a conducting fluid as the Reynolds number R increases. When R is large a magnetic field can appear spontaneously through the growth of infinitesimal perturbations in the field. The growth of the perturbations is limited by the influence of Lorentz forces on the motion; as a result the stationary amplitude of the field will under certain conditions increase like $(R - R_*)^{1/2}$, where R_* is a critical number. (auth)

41767 POSSIBLE MECHANISM FOR THE ACCELERATION OF IONS IN SOME ASTROPHYSICAL PHENOMENA. Friedman, M. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Rev., 182: 1408-14(June 25, 1969).

A model is suggested for the acceleration of ions, based on Petschek's theory of magnetic-field annihilation. It is shown that ions can gain high energies in this model, and that energy distributions similar to those observed can be obtained. It is also shown that this model prevents electrons from gaining high energy, consistent with cosmic-ray observations. It is suggested that if this model is correct, one can obtain, from the observed ion energy distribution, a relation between the (average) plasma density and the (average) magnetic field in regions where the ions are accelerated. (auth)

Cosmic Ray Exposure Ages

41768 CORRELATION BETWEEN FISSION TRACKS AND FISSION TYPE XENON IN METEORITIC WHITLOCKITE. Wasserburg, G. J.; Huneke, J. C.; Burnett, D. S. (California Inst. of Tech., Pasadena). J. Geophys. Res., 74: 4221-32(Aug. 15, 1969).

Whitlockite from the St. Severin chondrite, previously shown to contain excess fission tracks, is here shown to have a large concentration of excess neutron-rich xenon isotopes. The concentration of excess heavy Xe in the whitlockite is about twenty-five times that calculated from the track density. An isotopic spectrum is deduced that is identical to the spectrum calculated previously for excess heavy xenon in the Pasamonte achondrite. These results uniquely associate this xenon spectrum with in situ fission in meteorites. Chemical arguments support the correlation of this with ^{244}Pu. Identification of the fissioning nucleus as ^{244}Pu gives $^{244}\mathrm{Pu}/^{238}\mathrm{U} \approx 1/_{30}$. Neither "sudden" nor "uniform" nucleosynthetic models give consistent solutions for $^{244}\mathrm{Pu}/^{238}\mathrm{U}$ and $^{235}\mathrm{U}/^{238}\mathrm{U}$. (auth)

41769 ISOTOPIC ANALYSES OF BARIUM IN METEORITES AND IN TERRESTRIAL SAMPLES. Eugster, O.; Tera, F.; Wasserburg, G. J. (California Inst. of Tech, Pasadena). J. Geophys. Res., 74: 3897-3908(July 15, 1969).

Isotopic composition and concentration of barium in six stone meteorites and the silicate inclusions of two iron meteorites and three terrestrial samples were measured by use of a "double spike" isotopic dilution technique in order to correct for laboratory fractionation. Any differences between the abundances of the isotopes in meteoritic and terrestrial Ba were found to be less than 0.1% for all isotopes. The per cent abundances of Ba found for ^{138}Ba, ^{137}Ba, ^{136}Ba, ^{135}Ba, ^{134}Ba, ^{132}Ba, and ^{130}Ba are 71.699, 11.232, 7.853, 6.592, 2.417, 0.1012, and 0.1058, respectively. Because of the higher precision, these abundances should replace the currently accepted values. These results show the variations in the Ba isotopes reported by Umemoto (1962) to be unsubstantiated. (auth)

41770 ISOTOPIC ANALYSES OF KRYPTON AND XENON IN FOURTEEN STONE METEORITES. Eugster, O.; Eberhardt, P.; Geiss, J. (Univ., Bern). J. Geophys. Res., 74: 3874-96 (July 15, 1969).

The concentrations and isotopic compositions of Kr and Xe in twelve chondrites and two achondrites were determined. In addition to the trapped component, Kr and Xe produced by spallation and (n,$\gamma\beta$) reactions as well as fission and radiogenic Xe were found. Because of the chemical uniformity of the ordinary chondrites the concentrations of spallation-produced Kr and Xe found in these meteorites correlated with the concentrations of the spallation-produced light rare gases. It is shown that variations in the Kr spallation spectrum are caused by differences in the hardness of the energy spectrum, which are also responsible for the variations in the spallation ratio $^{21}\mathrm{Ne}/^{3}\mathrm{He}$ in ordinary chondrites. Excesses of ^{80}Kr, ^{82}Kr, and ^{128}Xe produced by capture of secondary neutrons in Br and I, respectively, are sensitive indicators for shielding and preatmospheric meteorite sizes. Neutron slowing down densities and minimal preatmospheric radii and masses were calculated on this basis for some of the investigated chondrites. ^{81}Kr radiation ages were obtained for three chondrites and for the achondrites. For the chondrites and for a Ca-poor achondrite the ^{81}Kr ages agreed with the ages calculated from the ^{3}He concentrations. However, the Ca-rich achondrites showed ^{81}Kr ages up to one order of magnitude higher, indicating ^{3}He diffusion losses. A remarkable correlation between the concentrations of Br and trapped Ar, Kr, and Xe in chondrites was found. The isotopic compositions of the trapped components in Kr- and Xe-rich ordinary chondrites were found to agree with those known for carbonaceous chondrites; however, the Khor Temiki achondrite seemed to differ in this respect. For the Mezö Madaras chondrite a sample of unequilibrated host material and a sample of an inclusion of equilibrated material were analyzed for all five rare gas elements. The spallation components of both samples were in excellent agreement, whereas the concentrations of trapped Ne, Ar, Kr, and Xe were about twenty times higher in the unequilibrated sample. (auth)

Stars

Refer also to abstract 42523.

41771 (NYO-3962-1) RESEARCH IN NUCLEAR PHYSICS AND NUCLEOSYNTHESIS. Annual Progress Report, June 1, 1968–May 31, 1969. Cameron, A. G. W. (Yeshiva Univ., New York. Belfer Graduate School of Science). Mar. 3, 1969. Contract AT(30-1)-3962. 16p. Dep. CFSTI.

Nuclear quantities desirable to predict from a theoretical basis include the masses, the level densities, the radiation widths, and various types of neutron cross sections. A major new effort has been underway for the last two years to improve the ability to make reasonable predictions of these quantities in the extreme neutron-rich region off the valley of beta stability. This program is briefly described and abstracts of papers published are presented. (W.D.M.)

41772 A STUDY OF THE ATMOSPHERES OF THE HOT SUBDWARFS HD 127493, HD 128220, AND HD 113001. Tomley, Leslie Jens. Seattle, Univ. of Washington, 1968. 243p.

Thesis.

An analysis of three hot subdwarfs, HD 127493 and the subdwarf components of the binary systems HD 128220 and HD 113001, was performed in order to obtain quantitative information about these previously unstudied objects. Moderately high-dispersion spectrograms (13 to 16 Å/mm) were used to determine the atmospheric parameters. The separation of the contributions to the continuum of each member of the binary systems was accomplished by using published spectral scans for stars of the same spectral class and the predictions of the model atmospheres. The observed profiles of the H I and He II lines, which are broadened primarily by Stark effect, were compared to profiles predicted from the model atmospheres and the theory of line broadening in a plasma. HD 127493 and HD 113001 are found to be well represented by models with $T_e = 41000$ and $40000°K$, $\log g = +5.7$ and $X = 0.5$ while HD 128220 requires that $T_e = 41000°K$, $\log g = +4.8$ and $X = 0.6$. Using the observed equivalent widths and Unsöld's method of weighting functions, the abundances of Ne and Si were found to be normal while N was enhanced and C and O were diminished from normal abundances in HD 127493 and HD 113001. The results for HD 128220 were somewhat uncertain but Ne and Si were normal and some rearrangement of the CNO abundances is possible within the experimental limits. The presently observed atmospheric abundances were examined from the standpoint of stellar evolution and nuclear processing. A scheme is presented by which the hot subdwarfs are consistent with the assumption of an initially normal composition and mixing of the outer regions of the stars at some later stage of development. (Diss. Abstr.)

41773 THE FORMATION OF POLAR AND EQUATORIAL CONDENSATIONS OF PLASMA IN THE PROXIMITY OF A CHANGING MAGNETIC DIPOLE. Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Astrophys. Space Sci., 4: 246-51 (June 1969).

The motion of a plasma in a time-dependent dipole magnetic field is considered. It is shown that the increase of the magnetic moment of the dipole (for example, as the result of the explosion of a magnetic star) leads to a concentration of a plasma in the polar regions. Likewise, a decrease of the magnetic moment (contraction of a star) would lead to the concentration of surrounding plasma in the equatorial plane. This process may be of importance in astrophysics and, particularly, in the dynamics of nebulae and nonstationary star envelopes. (auth)

41774 A SIMPLE APPROXIMATION FOR J_ν (σ_ν, K_ν, τ_ν, B_ν), AND ITS APPLICATION FOR TEMPERATURE-CORRECTION PROCEDURES. Boehm-Vitense, Erika (Univ. of Washington, Seattle). Astrophys. Space Sci., 4: 233-9(June 1969).

For the case of isotropic coherent scattering plus absorption a simple expression is given to compute the mean intensity of the radiation J_ν (as a function of optical depth τ_ν) if the scattering coefficient K_ν, and the Planck function B_ν are given as a function of depth. In general the accuracy of this approximation is of the order of a few percent. A fairly simple temperature-correction procedure for the case when scattering is important is described. (auth)

41775 ATMOSPHERES OF EXTREME METAL-DEFICIENT STARS. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Space Sci., 4: 218-32(June 1969).

Atmospheric models were constructed for effective temperatures 4000, 4500 and 5000° and for hydrogen-to-metal ratios of 1, 10^2, 10^3, and 10^4 times the solar values, and for surface gravities of 2×10^4 and 2×10^2. The effect of metal deficiency on the atmospheric structure of these stars was studied. (auth)

41776 A RELAXATION METHOD FOR THE COMPUTATION OF MODEL STELLAR ATMOSPHERES. Price, Michael J. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. Space Sci., 4: 182-212(June 1969).

A general Monte Carlo relaxation method has been formulated for the computation of physically self-consistent model stellar atmospheres. The local physical state is obtained by solving simultaneously the equations of statistical equilibrium for the atomic and ionic level populations, the kinetic energy balance equation for the electron gas to obtain the electron temperature, and the equation of radiative transfer. Anisotropic Thomson scattering is included in the equation of transfer and radiation pressure effects are included in the hydrostatic equation. The constraints of hydrostatic and radiative equilibrium are enforced. Local thermodynamic equilibrium is assumed as a boundary condition deep in the atmosphere. Elsewhere in the atmosphere LTE is not assumed. The statistical equilibrium equations are solved with no assumptions made concerning detailed balance for the bound–bound radiative processes. The source function is formulated in microscopic detail. All atomic processes contributing to the absorption and emission of radiation are included. The kinetic energy balance equation for the electron gas is formulated in detail. All atomic processes by which kinetic energy is gained and lost by the electron gas are included. The method has been applied to the computation of a model atmosphere for a pure hydrogen early-type star. An idealized model of the hydrogen atom with five bound levels and the continuum was adopted. The results of the trial calculation are discussed with reference to stability, accuracy, and convergence of the solution. (auth)

41777 ACCELERATION OF ULTRARELATIVISTIC ELECTRONS IN THE CRAB NEBULA. Melrose, D. B. (Yeshiva Univ., New York. Univ. of Maryland, College Park). Astrophys. Space Sci., 4: 165-81(June 1969).

Ultrarelativistic electrons must be being accelerated in the Crab Nebula to maintain the synchrotron spectrum. Sufficient power to maintain the synchrotron spectrum is supplied by an observed damping of compressional motions in the central region of the nebula (the "wisps" of Baade). An acceleration mechanism which involves compressional motions, the gyrorelaxation effect and the removal of pitch angle anisotropies by the generation of hydromagnetic waves is formulated and applied to a model of the Crab Nebula with acceleration confined to a central region. This can account for the power supplied to the electrons, the overall shape of the spectrum and allows acceleration up to energies corresponding to the synchrotron emission of hard x rays. The acceleration process tends to flatten an initial energy spectrum. (auth)

41778 RESONANT INTERACTION OF HYDROMAGNETIC WAVES WITH CHARGED PARTICLES. Melrose, D. B. (Yeshiva Univ., New York. Univ. of Maryland, College Park). Astrophys. Space Sci., 4: 143-64(June 1969).

The effect of the resonant interaction of a distribution of hydromagnetic waves on a distribution of particles is described by a diffusion equation in momentum space. The diffusion coefficients and other coefficients describing systematic acceleration and diffusion in energy space are derived in general and for a number of particular cases. It is shown that the resonant acceleration of slow ions by hydromagnetic waves is ineffective. The time evolution of the energy spectrum for ultrarelativistic particles due to interaction with hydromagnetic waves is found and applied to the case of the Crab Nebula in an accompanying article. (auth)

41779 NEUTRAL HELIUM LINES AND DEPARTURES FROM LTE IN HOT STARS. Johnson, H. R.; Poland, A. I. (Indiana Univ., Bloomington). J. Quant. Spectrosc. Radiative Transfer, 9: 1151-65(Aug. 1969).

Although the weakening of the singlet lines of neutral helium relative to the corresponding triplets along the spectral sequence in both directions from B3 has been known for many years, the explanation is still uncertain. To assess the importance of departures from thermodynamic equilibrium among the populations of the bound states of He I in explaining the observations, departures for several model helium atoms, including some with levels through n = 20, in model atmospheres of 20,000, 30,000, and 40,000 K. The coupled equations of radiative transfer and steady state were solved for all significant bound–bound transitions and for all bound–free continua. (TSS) (UK)

41780 LINE STATISTICS FOR SOLAR TYPE STARS. Boehm-Vitense, E. (Univ. of Washington, Seattle). J. Quant. Spectrosc. Radiative Transfer, 9: 1167-90(Aug. 1969).

The wavelength interval from 3100 to 8200 Å was divided into 16 spectral regions. In each region all of the lines were combined to form one line with the same distribution of κ_v as all the lines together. Values of $\Delta\lambda_m$ were calculated for which $\kappa_v = \kappa_0 \exp(-m)$. Tables for $\Delta\lambda_5$, $\Delta\lambda_{10}$ and $\Delta\lambda_{15}$, as well as for κ_0 are given as a function of the gas pressure P_g and the temperature T. (auth) (UK)

41781 THE 10,830A He I LINE IN THE ENVELOPE OF BETA LYRAE. Alduseva, V. Ya.; Esipov. V. F. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 83-5(July-Aug. 1969).

Translated from Astron. Zh., 46: 113-16(Jan.-Feb. 1969).

The profile of the 10,830-Å line of He I in the envelope of β Lyr is derived from observations made in August–September–October 1962. A contact electronic image converter served as the radiation receiver. The expansion velocity of the envelope, the intensity ratio of the red and violet components of the emission line, the equivalent width of the emission line, and the residual intensity at the center of the absorption line are determined as a function of the brightness phase. The emission line exhibited enhancements near primary eclipse (greatest at phases 0.10 to 0.15) and after secondary minimum. An analysis of the structure of the 10,830-Å line and its behavior with brightness phase indicates that the line arises in the outermost parts of the envelope, which surround the β Lyr system as a whole. (auth)

41782 THE BLUE COMPANION OF DELTA CEPHEI δ(CEP C). Vitrichenko, E. A.; Tsarevskii, G. S. (Crimean Astrophysical Observatory, Moscow. Radio Astrophysical Observatory, Riga). Sov. Astron. AJ (Engl. Transl.), 13: 159-61(July–Aug. 1969).

Translated from Astron. Zh., 46: 211(Jan.-Feb. 1969).

The radial velocity of δ Cep C, the blue companion of the Cepheid δ Cep, exhibits rapid variability, indicating that it may be a spectroscopic binary. Photoelectric observations have revealed no sign of an eclipse or physical variability. The behavior of the interstellar absorption in the direction toward δ Cep and certain other considerations suggest that δ Cep A and C are neighbors in space. (auth)

41783 RADIATION BY MAGNETOSONIC WAVES GENERATED IN A STELLAR WIND. Brengauz, V. D. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 13: 37-41(July-Aug. 1969).

Translated from Astron. Zh., 46: 49-55(Jan.-Feb. 1969).

The Cherenkov radiation of the magnetosonic waves resulting from the corpuscular interaction of a star with the ambient gas is considered. The star is permitted to move at an arbitrary angle to the external magnetic field. Expressions are derived for the perturbation fields, and the radiant intensity of the waves is estimated. (auth)

41784 A MODEL FOR THE FINE RADIAL FILAMENTS OBSERVED IN THE PLANETARY NEBULA NGC 7293. Yankulova, I. M. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 32-6(July-Aug. 1969).

Translated from Astron. Zh., 46: 43-8(Jan.-Feb. 1969).

A model is developed for the fine radial filaments observed in the planetary nebula NGC 7293. It is shown that they are formed from the density fluctuations in the envelope of the nebula under the action of ionization waves and shock waves. The lifetime of the filaments is determined by the rate of propagation of these waves. Filaments are absent from the region $r < 0.03$ pc because they are able to dissipate within a time $t = 2.5 \times 10^3$ yr after formation of the Strömgren zone. The dynamics of the formation of the filaments is also discussed. (auth)

41785 NEUTRONIZATION OF MATTER AT HIGH DENSITIES. Chechetkin, V. M. Sov. Astron. AJ (Engl. Transl.), 13: 157-8(July-Aug. 1969).

Translated from Astron. Zh., 46: 206-8(Jan.-Feb. 1969).

The problem of the neutronization of matter at high densities is considered for the case of statistical equilibrium with respect to nuclear reactions, for nuclei, and for free nucleons. The role of nuclei overloaded with neutrons in this process is investigated. The neutronization boundary of the material is established, that is, the boundary where the concentration of neutrons by weight is $x_n = 1/2$. (auth)

41786 EQUILIBRIUM STATE OF MATTER AT HIGH TEMPERATURES AND DENSITIES. Chechetkin, V. M. Sov. Astron. AJ (Engl. Transl.), 13: 153-6(July-Aug. 1969).

Translated from Astron. Zh., 46: 202-6(Jan.-Feb. 1969).

The problem of the state of matter at high temperature ($4 \times 10^9 < T < 20 \times 10^9$°K) and densities ($10^5 < \rho < 10^{12}$ g/cm^3) is discussed. Under these conditions statistical equilibrium for nuclear reactions obtains between nuclei and free nucleons. The neutron/proton ratio is determined by kinetic equilibrium with regard to β processes. Under these assumptions the chemical composition of the material is derived as a function of temperature and density. (auth)

41787 INTERACTION OF STARS WITH THE INTERSTELLAR MEDIUM. Radzievskii, V. V.; Dagaev, M. M. (Gorky Teachers' Coll., USSR. Lenin Teachers' Coll., Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 42-8(July-Aug. 1969).

Translated from Astron. Zh., 46: 56-65(Jan.-Feb. 1969).

A law is derived for the distribution of the density ρ of the galactic diffuse medium as a function of spherical coordinates within the sphere of influence of a star, with allowance for repulsion by the stellar radiation. This law is used to determine the force accelerating or decelerating the motion of the star. It is established that the rarefaction of optically effective particles which arises in the antapex hemisphere will lead to an anisotropy in stellar brightness: stars observed from the apex side, thereby having a negative radial velocity $V_r < 0$, should on the average be fainter than stars having $V_r > 0$. The density law derived here is used to compute the mean difference $\Delta\overline{m}$ in the brightness of B stars having negative and positive values of V_r, for various spectral subtypes. The theoretical calculations are shown to agree well with the observational data. The results of a reduction of Parenago's catalog of B stars indicate that B stars with $V_r > 0$ are brighter by $\Delta\overline{m} = 0.7^m$, on the average, than stars having a negative radial velocity. (auth)

41788 HIGHLIGHTS OF ASTRONOMY. As Presented at the XIIth General Assembly of the International Astronomical Union, Held in Prague, 22–31 August 1967. Perek, Lubos (ed.). New York, Springer-Verlag New York Inc., 1968. 555p. $27.60. (CONF-670847).

This volume includes 73 papers (4 Invited Discourses, 60 Joint Discussions, and 9 Special Meeting), which are the Highlights of Astronomy, 1967. It is emphasized, though, that 140 Commission Meetings were held during the General Assembly that could not be included here; these results can be found in astronomical journals and in the publications of observatories. The invited discourses included: Exploring the Moon by A. A. Mahailov; External Layers and Internal Structure of Stars by P. Ledaux; and Radio Galaxies and Quasi-Stellar Sources (Parts I and II) by M. Ryle and A. Sandage. The joint discussions dealt with the following subjects: new techniques in space astronomy; x-ray astronomy; the lithium problem; modern problems of fundamental astrometry; extragalactic radio sources; and close binaries and stellar evolution. Papers from two special meetings, Moon Probes and Coordination of Solar Observations made at Ground-based Observatories and with Space Vehicles, were deemed to be of sufficiently wide interest to warrant inclusion in this volume. (L.M.T.)

41789 PULSATIONAL PROPERTIES OF A MASSIVE STAR IN THE HELIUM-BURNING PHASE. III. Prasad, C.; Mohan, C. (Univ. of Roorkee, India). Mon. Notic. Roy. Astron. Soc., 144: 179-88(1969).

The pulsational stability of the first four modes of pulsation of a star of 15.6 solar masses in the helium-burning phase of its evolution was studied. The pulsational stability of the modes was first studied in quasi-adiabatic approximation. The effects of the nonadiabatic terms of the outer layers and the destabilizing effects of the region of second helium ionization were then considered for the various modes. (auth) (UK)

41790 OCCURRENCE OF SEMI-CONVECTION IN MASSIVE STARS. Tayler, R. J. (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 231-3(1969).

It is pointed out that the semi-convection zones which are commonly supposed to separate the convective core and radiative envelope in massive stars represent only one mathematical solution to a physical problem. A second mathematical solution is presented and it is suggested that the solution that is physically correct may be determined by stability considerations. (auth) (UK)

41791 EXPANDING ATMOSPHERES IN OB SUPERGIANTS. III. P CYGNI. Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, British Columbia). Mon. Notic. Roy. Astron. Soc., 144: 235-43(1969).

Spectroscopic observations of P Cygni indicate the existence and structure of an extended accelerating envelope about the star. The structure is used as a basis for strong line-profile computations, and modified to match computed and observed profiles. The final atmospheric structure resembles that found for three other supergiants and indicates a rate of mass loss from P Cygni of 5×10^{-4} $M_\odot yr^{-1}$. (auth) (UK)

41792 ISENTROPIC STARS IN GENERAL RELATIVITY. Kovetz, A. (Tel-Aviv Univ., Israel). Astrophys. Space Sci., 4: 365-9(July 1969).

In an investigation of the evolution of homogeneous, isentropic, stars through stages of diminishing entropy, Rakavy and Shaviv (1968) have recently found that stars of mass less than $\underline{M}_e$ (Chandrasekhar's limiting mass for white dwarfs) evolve into white dwarfs, while stars of mass greater than $\underline{M}_e$ approach a (singular) state of minimum entropy. An elementary explanation of these results is given and qualitative effects of general relativity are discussed. It is found that stars which are lighter than the Oppenheimer and Volkoff (1939) limit become white dwarfs, while heavier stars must become dynamically unstable at a finite stage in their evolution. (auth)

41793 EQUILIBRIUM AND STABILITY OF MAGNETO-POLYTROPES. Anand, S. P. S. (Univ. of Toronto). Astrophys. Space Sci., 4: 255-74(July 1969).

The theory of the oscillations of axisymmetric gaseous configurations with a prevalent magnetic field is presented. The virial tensor method is used to obtain the nine second harmonic modes of oscillations of the system. It is found that out of the nine modes, three are neutral, four are nonradial, and two are coupled. For the Prendergast spherical model it is found that one of the coupled modes is radial and the other nonradial. Both the radial and the nonradial modes obtained in this case agree with the corresponding formulae obtained by Chandrasekhar and Limber (1954) and Woltjer (1962). The equilibrium structure of gaseous polytropes with toroidal magnetic fields is also investigated in detail for values of the polytropic index n = 1, 1.5, 2, 3, and 3.5. For this model the components of the moment of inertia and potential energy tensors together with the nonzero components of the supermatrix potential are obtained. The final results in terms of the effect of weak toroidal magnetic fields on the characteristic frequencies of distorted polytropes are presented in the form of tables. (auth)

41794 NEW STATE OF FERROMAGNETISM IN DEGENERATE ELECTRON GAS AND MAGNETIC FIELDS IN COLLAPSED BODIES. Lee, Hyung Joon (Brookhaven National Lab., Upton, N. Y.); Canuto, Vittorio; Chiu, Hong-yee; Chiuderi, Claudio. Phys. Rev. Lett., 23: 390-3(Aug. 18, 1969).

A new state of "ferro" magnetism in a degenerate electron gas is found and shown to be stable. This magnetism is the sum of all microscopic magnetic moments associated with electrons in their respective Landau levels while the Landau levels of the system are in turn maintained by this macroscopic magnetization.

The maximum field in the Landau orbital ferromagnetism state is 10^7 G for white-dwarf densities and 10^{12} G for neutron-star densities. (auth)

41795 THEORETICAL STUDIES ON STELLAR STABILITY. 1. GENERAL METHOD AND SIMPLE APPLICATIONS. Unno, Wasaburo (Tokyo Univ.). Publ. Astron. Soc. Jap., 20: 356-75(Dec. 1968).

Stability of a self-gravitating gaseous mass is formulated on the basis of the general variational method developed by Prigogine and Glansdorff, for the most general case in which the perturbation is nonadiabatic and the unperturbed configuration may be contracting, rotating differentially, and moving internally. The characteristic equation which determines the complex frequencies of oscillation is derived. For adiabatic oscillations of a steady configuration, this equation reduces to Lynden-Bell and Ostriker's equation of the ordinary generalized variational principle. With the help of the characteristic equation, the stability criterion is derived formally for nonadiabatic oscillations of a uniformly rotating equilibrium configuration. The stable cases are classified into three types. As another illustration of the general method, the stability of a homologously contracting star is examined analytically for the case of the homologous oscillations. The result of Kato and Unno is thus confirmed in a straightforward analysis. The scale change of the unperturbed configuration is found to be an additional cause of exciting the pulsation other than the gravitational ϵ mechanism. (auth) (NSA of Japan)

41796 CRITERIA FOR FERROMAGNETISM IN DENSE NEUTRON FERMI LIQUIDS: NEUTRON STARS. Silverstein, S. D. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev. Lett., 23: 139-41(July 21, 1969).

The ferromagnetic phase boundary and intrinsic neutron spin polarization are calculated as a function of the strength and range of the neutron forces, and the density of the neutron liquid. This system is discussed within the context of neutron stars. (auth)

41797 OBSERVATIONS OF INTERSTELLAR MOLECULAR HYDROGEN. Werner, Michael Wolock. Ithaca, N. Y., Cornell Univ., 1968. 203p.

Thesis.

An observational program for the detection of interstellar molecular hydrogen has been conceived and carried out. The observational technique involves a search for vibration-rotation emission lines from the ground electronic state of H_2. These lines are produced in a resonance fluorescence process initiated by an electronic absorption in the ultraviolet bands of H_2, followed by de-excitation into an excited vibrational level of the ground electronic state and a cascade into the ground vibrational level. A detailed theory of this radiative cascade process has been developed. The sources observed in this program included the Orion Nebula, the OH emission source W3, a bright rim in the HII region IC 1396, and a portion of an opaque interstellar cloud near ρ Ophiuchus. All observations were made with a 1.2′ field of view. For the latter three sources, an upper limit of $\sim 10^5$ photons/cm^2-sec-sr has been set on the flux in each of the lines observed. (TSS) (Diss. Abstr.)

41798 PHOTOELECTRIC LINE PHOTOMETRY OF EARLY B-TYPE STARS. Sinnerstand, U.; Arkling, J.; Alm, S. H.; Brattlund, P. (Stockholm Observatory). Ark. Astron., 5: 105-24 (1969).

The intensities of the absorption lines $H\beta$, $H\gamma$ and He I 4471 were determined by means of narrow-band technique. Although this technique is most important for measures of broad spectral features such as the hydrogen lines in early type stars, the accuracy of the photoelectrically determined He I 4471 index is nevertheless comparable with the accuracy achieved in measurements of equivalent widths from high-dispersion spectra. The Be stars are easily selected from a plot of $H\beta$ versus $H\gamma$. A photoelectric method is finally developed for the determination of the projected rotational velocity of the stars, v × sin i. (SWED)

41799 DETERMINATION OF INTERSTELLAR ABSORPTION IN SA 19 USING LOW-DISPERSION SPECTRA. Solheim, J.-E.; Stabell, R. (Inst. of Theoretical Astrophysics, Oslo). Ark. Astron., 5: 137-47(1969).

Densities in spectra of stars in Kapteyn's Selected Area No. 19 taken with a Schmidt camera were measured and correlated with the corresponding monochromatic magnitudes in Elvius' reference catalogue (1951). An analytical expression for the calibration curve was found. Line parameters for 84 stars were determined and the stars were classified according to the Uppsala spectral classification system. Their colors and absolute magnitudes were also calculated. The color excess as a function of distance was then determined and the absorption out to 2 kpc was found. (SWED)

41800 PHOTOELECTRIC BV PHOTOMETRY OF 368 NORTHERN STARS. Haeggkvist, Love; Oja, Tarmo (Astronomical Observatory, Uppsala). Ark. Astron., 5: 125-35(1969).

Photoelectric measurements of V and B−V are presented for 368 stars, mainly in three regions: the Milky Way in Cassiopeia and Perseus, an area around the North Galactic Pole, and Kapteyn's Selected Area 17. (SWED)

41801 TWENTY-FOUR SOUTHERN PECULIAR EMISSION-LINE STARS. Carlson, Eric Dungan. Evanston, Ill., Northwestern Univ., 1968. 232p.

Thesis.

Observational data are presented for 24 peculiar emission-line stars (and a few associated nebulae) located largely along the fourth quarter of the galactic equator. These rather diverse stars have one common characteristic—emission-line spectra of a type which suggests mass ejection at an extraordinary rate. The core of the group of stars may be regarded as P Cygni stars. Others were included because of their probable or possible relationship to P Cygni stars and to the problem of stellar evolution by mass ejection. Such related types include novae and nova-like stars, several unusual nuclei of planetary nebulae, symbiotic stars, peculiar binaries, unusual Bep and Of stars, and several stars so peculiar as to defy classification. (TSS) (Diss. Abstr.)

41802 IMPACT THEORY OF THE BROADENING AND SHIFT OF SPECTRAL LINES DUE TO ELECTRONS AND IONS IN A PLASMA (CONTINUED). Sahal-Brechot, S. (Observatoire, Meudon, France). Astron. Astrophys., 2: 322-54(July 1969). (In French).

In a previous paper (Sahal-Bréchot, 1969) the theoretical impact treatment of the collisional broadening and shift of spectral lines were developed and the collisional matrix elements which appear in the calculation of the widths and shifts in the framework of the semi-classical approximation were calculated, the perturbers being electrons and ions. The validity conditions for the various approximations made were given. This study is continued by concluding the semi-classical calculations of line widths and shifts. (auth)

41803 SECULARLY UNSTABLE DIFFERENTIAL ROTATION IN STARS. Kippenhahn, R. (Univ., Goettingen, Ger.). Astron. Astrophys., 2: 309-15(July 1969).

With a rough model for the disturbances which occur in a star if the angular velocity distribution is secularly unstable, the time scale of diffusion of angular momentum throughout the star due to this instability is estimated. It is shown that this time scale is of the order of the Kelvin–Helmholtz time scale or longer. (auth)

41804 HYDROMAGNETIC OSCILLATIONS AND STABILITY OF SELF-GRAVITATING MASSES. II. COMPRESSIBLE FLUID SPHERE. Singh, Surindar; Tandon, J. N. (Univ. of Delhi). Astron. Astrophys., 2: 266-73(July 1969).

Oscillations and stability of a homogeneous compressible fluid sphere with an axisymmetric magnetic field for the P_2-deformations were studied using a variational principle. In the first approximation, a single nontrivial Kelvin mode was found. In the second approximation three modes of oscillation, a Kelvin-type mode, a pulsation mode, and a convectively unstable mode were found. The characteristic frequency of the stable modes increases with a low magnetic field. A small magnetic field suppresses the convectively unstable mode. (auth)

41805 INTRINSIC REDDENING OF ETA CARINAE. Lambert, D. L. (California Inst. of Tech., Pasadena). Nature (London), 223: 726-8(Aug. 16, 1969).

A criticism is offered concerning a proposed new method for the determination of the intrinsic and interstellar reddening for "peculiar objects," based on the intensities of the forbidden lines of ionised Fe, and which was applied to Eta Carinae (Pagel, Nature 221: 325(1969)). It is stated that the method is based on the assumption that the excited levels are populated according to a Boltzmann distribution, and that the lines selected originated from levels with similar excitation potentials, leading to the assumption that the analysis was insensitive to an uncertainty in the adopted excitation temperature. It is suggested that this assumption is invalid, and a revision of Pagel's method is proposed. The discussion is based on the emission line intensities obtained from coudé spectra, and it is stated that the proposed revision does not require an assumption concerning a Boltzmann distribution. A reply by Pagel is included. (UK)

41806 INTERSTELLAR EXTINCTION IN THE ULTRAVIOLET. II. Stecher, Theodore P. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 157: L125-6(Aug. 1969).

Interstellar extinction in the ultraviolet was determined from the spectra of ζ and ε Persei, and results are presented. (auth)

41807 INTERNAL MOTIONS IN THE ORION NEBULA. Lee, Paul (Louisiana State Univ., Baton Rouge). Astrophys. J., 157: L111-12(Aug. 1969).

Slit-spectroscopic observations of a bright region near the Trapezium in the Orion Nebula show evidence of matter with a mean radial velocity of approach of about 60 km sec^{-1} with respect to the nebula. (auth)

41808 ON THE FAR-ULTRAVIOLET INTERSTELLAR EXTINCTION LAW IN THE ORION NEBULA REGION. Carruthers, George R. (Naval Research Lab., Washington, D. C.). Astrophys. J., 157: L113-17(Aug. 1969).

A rocket measurement of the far-ultraviolet spectral intensity of θ Orionis in the range 1000 to 1350 Å has shown that the flux is far too great to be consistent with predictions based on previous ultraviolet extinction measurements and the observed $E(B - V)$. Comparison with model atmospheres and with other stars observed indicates ultraviolet color excesses $E(1115 - V) = 0.37$ mag and $E(1270 - V) = 0.53$ mag, as compared with the average $E(B - V)$ of 0.276 mag. Hence, instead of varying as $1/\lambda$, the far-ultraviolet portion of the extinction curve appears to be flat, or even decreasing toward shorter wavelengths. (auth)

41809 NUCLEAR Q VALUES IN A DENSE STELLAR PLASMA. Shaw, Peter B. (Pennsylvania State Univ., University Park). Phys. Rev., 182: 1369-73(June 25, 1969).

Corrections to nuclear Q values in a dense stellar plasma are calculated by means of a modified ionic cluster expansion in which the electrons are treated as a dielectric medium. Corrections beyond the weak-screening (Debye) approximation are given in tabular form for purposes of interpolation. A comparison between the Debye correction and the double-cluster correction is made for the chemical potential of a one-component plasma; the latter correction is ~20% of the former for a plasma parameter as large as unity. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 41175 and 42039.

41810 PULSAR SLOWDOWN RATES FOR CP 0328 AND HP 1506. Cole, T. W. (Cambridge Univ., Eng.). Nature (London), 223: 487(Aug. 2, 1969).

Timing observations for the above pulsars were made with the four-acre 81.5-MHz array at the Mullard Radio Astronomy Observatory since June 1968. It appears that CP 0328 is slowing down by 60 nsec/yr and HP 1506 by 167 nsec/yr. If pulsars derive their pulsation energy from stellar rotation, a simple relation might be expected between the rate of increase of the period and the period itself. The present results show that no such simple relation exists for pulsars with periods longer than about 0.25 sec. It follows that the simple rotational models must have parameters that vary considerably between sources. Such parameters might be strength of the stellar magnetic dipole moment, inclination between rotation axis and magnetic axis, conditions in the plasma surrounding the star, etc. A relationship between rate of change of period and period itself might then be found only if the slowdown rate could be combined with other observed pulsar quantities in a detailed source model. (UK)

41811 VOLCANO THEORY OF PULSARS. Dyson, F. J. (Inst. for Advanced Study, Princeton, N. J.). Nature (London), 223: 486(Aug. 2, 1969).

It is stated that it may be possible that neutron stars have superadiabatic temperature gradients in their outer layers, but convection in the ordinary sense cannot occur in neutron star envelopes since these envelopes are solid. The question then arises as to how heat can be transported through the solid mantle of a neutron star which is convectively unstable. It is postulated that some weak points will develop through which liquid material from the core will pour out to the surface; in other words, energy will be transported by "volcanic" action. Differences between neutron star "volcanoes" and terrestrial volcanoes are pointed out; in the former, material will emerge like a hypersonic jet from a rocket nozzle rather than like a lava flow. Volcanic channels in a neutron star mantle are difficult to form and are likely to be more permanent than terrestrial volcanoes, once formed. The flow of material will continue steadily so long as a superadiabatic temperature gradient exists. The question remains as to how the hypersonic and perhaps relativistic jet gives rise to a directed beam of electromagnetic radiation, but magnetic fields must play an essential part. The "volcano" theory has the advantage of providing a large and continuous energy source, independent of the rotation of the star. The material will pass from the core to the surface in a time of the order of milliseconds, and will emerge with a large proportion of free neutrons and other radioactive species, and energy released by neutron decay and capture reactions may be relevant to the conversion to electromagnetic radiation. The amount of material flowing to the surface must be at least 10^6 g/cm²/sec., and probably much more. The sudden change in the period of the Vela pulsar may be due to a major earthquake in the mantle, and this may represent a sudden settling of the mantle under an accumulation of volcanic material; the mantle may thus collapse by about a centimeter at intervals of a few years. (UK)

41812 ATTEMPT TO OPTICALLY IDENTIFY PSR 0833-45. Hesser, J. E. (Cerro Tololo Inter-American Observatory, La Serena, Chile); Lasker, B. M.; Bochonko, D. R.; Mook, D. E. Nature (London), 223: 485-6(Aug. 2, 1969).

It is stated that this pulsar is an obvious candidate for optical identification, because of its similarity to the Crab Nebula pulsar and because of its relatively well-established coordinates. Observations were made on the nights of Feb. 19–20 and 20–21, 1969, using the 60-inch telescope at Cerro Tololo. The experimental setup and technique are outlined. Periodogram analysis indicated an upper limit for optical fluctuations in amplitude of B = 22.3 for a time-averaged magnitude. (UK)

41813 INTERSTELLAR HYDROXYL CLOUDS. Moran, James M. Jr. (Massachusetts Inst. of Tech., Cambridge). Sci. J., 5A: 60-5(Aug. 1969).

Some regions of space contain clouds of hydroxyl molecules, which are powerful sources of radio waves. The investigation of these clouds has called for new techniques in radio astronomy. Their intense emissions are probably caused by the operation of natural masers in space. (auth) (UK)

41814 STEADY RADIATION FRONTS BEHIND WINDOWS. Ahlborn, B.; Zuzak, W. W. (Univ. of British Columbia, Vancouver). Can. J. Phys., 47: 1709-21(Aug. 15, 1969).

If radiation of constant intensity W ionizes a gas density of ρ_1 behind a window, a steady radiation front may be established and the gas will be heated, accelerated, and compressed. The properties of such radiation-induced waves are discussed as a function of the external parameters W and ρ_1. With high absorber density ρ_1, the radiation front acts like a "leaky piston," accelerating and compressing the neutral gas ahead, and leaving plasma of reduced density behind. This leads to the formation of a precursing shock wave travelling at $v_{shock} \propto (W/\rho_1)^{1/3}$. The shock develops as a sharp spike near the Jouguet point which requires a sonic speed $a_4 \propto (W/\rho_1)_j^{1/3}$ in the ionized gas. With lower absorber density, the radiation front propagates as $v_r \propto W/\rho_1$ and accelerates and compresses the ionized gas at its rear. This plasma is then brought to rest and expanded in a subsequent rarefaction wave. (auth) (Canada)

41815 DISTANCE OF PULSARS AND THE INTERSTELLAR ELECTRON GAS. Davies, R. D. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 223: 355-8(July 26, 1969).

It is stated that information about the interstellar distribution of hydrogen can help to refine estimates of pulsar distances. (auth) (UK)

41816 GAMMA RADIATION FROM NP 0532. Apparao, M. V. K. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 223: 385-6(July 26, 1969).

The pulsar NP 0532, located in the Crab Nebula, emits pulses of polarized light the origin of which appears to be the synchrotron radiation process, indicating the presence of high-energy electrons; the gamma radiation resulting from various processes associated with these electrons is calculated. While gamma radiation from NP 0532 has not been observed experimentally, there are observations of gamma radiation from the Crab Nebula that give upper limits on gamma emission from NP 0532. The present calculations, together with these upper limits, lead to the conclusion that the magnetic field near the light-emitting region of NP 0532 is $10^2 \lesssim H \lesssim 10^4$G. Processes by which high-energy gamma radiation is produced are discussed; these include (1) the Compton-synchrotron process, (2) proton–proton interaction producing $\overline{\Lambda}^0$ mesons and their decay to gamma rays, and (3) bremsstrahlung. Calculated data are tabulated for processes (1) and (2); the gamma ray flux from process (3) is found to be negligible. (UK)

41817 QUANTUM INTERFERENCE PARADOX. Burke, B. F. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 223: 389-90(July 26, 1969).

The development of atomic time standards and high-speed recording techniques has allowed extension of radio interferometry to baselines of thousands of miles. The amplitude, rather than the power, of the received radiation is recorded separately at two or more stations with accurate time control, and the interference pattern is recovered by cross-correlating the signals. The measurements are usually described in classical terms, since it is considered that they are outside the domain of quantum phenomena. Discussion of the technique in quantum terms, however, raises an interesting form of the quantum interference paradox debated by Einstein, Bohr and others, some 40 years ago. This new form of the paradox is discussed. It was considered that any attempt to determine through which of two slits a photon or electron passes must result in destruction of the interference pattern. An apparent contradiction arises in that incoming photons can be detected at two antenna without disturbance of the interference pattern. The author shows that no conflict between classical and quantum physics arises in this case. The paradox is resolved by considering the properties of the amplifiers used, considered as masers; a single photon can be amplified by two amplifiers without destroying the interference. Despite the preservation of interference it is still not possible to detect individual photons at the antenna or slits because of the existence of spontaneous emission in any system having an absorption coefficient, and no device that increases amplitude, preserving phase, can display the amplitude and phase of single photons. (UK)

41818 PROGRESS IN RADIO AND RADAR ASTRONOMY. Erickson, W. C. (ed.) (Univ. of Maryland, College Park). Radio Sci., 4: 635-40(July 1969).

Topics covered in this three-year progress review include extragalactic source studies, background emission, galactic radio astronomy, solar system astronomy, and new instrumentation. 69 references. (W.D.M.)

41819 A SEARCH AT 15 GHz FOR COMPACT H II REGIONS IN REGIONS OF POSSIBLE STAR FORMATION. Churchwell, E.; Felli, M.; Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett., 4: 33-41 (Aug. 1969).

Regions surrounding ir stars, sources of anomalous OH emission, T Tauri stars, Hα emission regions of high surface brightness and small diameters, and young O-star clusters and associations were surveyed with the NRAO 140-ft telescope at 15.4 GHz. In addition, four ir stars associated with anomalous OH emission were surveyed at 1.4 GHz with the NRAO 300-ft telescope. Positive results were obtained for three sources of anomalous OH emission and some of the Hα emission nebulae and O star associations, respectively. In all other cases upper limits for the flux densities at 15.4 and 1.4 GHz are given. (auth)

41820 THE BUILDUP OF ELECTROMAGNETIC WAVES BY THE INDUCED COMPTON EFFECT AS A POSSIBLE SOURCE OF STRONG RADIO EMISSION. Kaplan, S. A.; Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow. Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 13: 150-2(July-Aug. 1969).

Translated from Astron. Zh., 46: 199-201(Jan.-Feb. 1969).

A relation is obtained enabling one to estimate the contribution of the induced Compton effect for relativistic electrons on the basis of observational evidence alone. It is shown that for quasars and pulsars the occurrence of a buildup of electromagnetic waves through the induced Compton effect may be inferred directly from data on the intensity of these objects, while the characteristic wavelengths at which the pumping (the maser effect) appears are much shorter than the diameters of the objects. The efficiency of the buildup will also be materially enhanced if the scattering of the amplified waves by plasma oscillations is taken into account. The latter circumstance suggests that for low frequencies a buildup through the induced Compton effect can occur in objects whose radiation density is considerably smaller than in quasars and pulsars. (auth)

41821 VARIABILITY OF RADIO SOURCES AT 6.6 cm WAVELENGTH. Lipovka, N. M. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.), 13: 21-7(July-Aug. 1969).

Translated from Astron. Zh., 46: 28-36(Jan.-Feb. 1969).

The results of observations of the quasars 3C 84, 120, 273, 279, and 345 at 6.6-cm wavelength with the large Pulkovo radio telescope ($\varphi_A = 2.2'$) are reported. All five sources exhibit a time variation of their flux density, which can be interpreted by the model of van der Laan and Shklovskii. An upper bound is estimated for the linear diameter of each source responsible for the variable radio emission in the centimeter range. The retardation in the expansion velocity of the relativistic-electron cloud is ascertained. (auth)

41822 A COMPUTER DETERMINATION OF THE 40cm FLUX DENSITY OF 3C 270 AND 3C 278. Rzhiga, O. N.; Trunova, Z. G. (Inst. of Radio Engineering and Electronics, Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 28-31(July-Aug. 1969).

Translated from Astron. Zh., 46: 37-42(Jan.-Feb. 1969).

The flux densities of the radio sources 3C 270 and 3C 278 at 40-cm wavelength have been measured as (26.4 ± 2.1) and (11.2 ± 1.3) $\cdot 10^{-26}$ W/m$^2 \cdot$ Hz respectively. Weighted mean values for the flux density have been computed on the BESM-2M, for which a special program applicable to the measurement of point sources was compiled. Unlike von Hoerner's program, the present program utilizes a curve best representing the radiometer response. Allowance is made in the computations for the linear component of the zero-level drift. The program enables preliminary coordinates of radio sources to be computed in the horizontal system, as required for the observations, and it can be applied for the purpose of measuring antenna parameters by radio-astronomy techniques. (auth)

41823 THE NATURE OF SOURCES OF MASER RADIATION IN OH LINES. Shklovskii, I. S. Sov. Astron. AJ (Engl. Transl.), 13: 1-4(July-Aug. 1969).

Translated from Astron. Zh., 46: 3-7(Jan.-Feb. 1969).

It is shown that the fine structure of the condensations—sources of maser radiation in the OH 1665- and 1667-MHz lines—observed recently in W3 cannot be explained as binarity. Actually a complex brightness distribution is observed in each of these condensations. For the simplest case of two bright spots on the condensation's limb, a model specifically explaining their circular polarization is proposed. Arguments are given that the condensations responsible for the OH maser radiation are protostars. (auth)

41824 NEUTRON-STAR QUAKES AND PULSAR PERIODS. Ruderman, M. (New York Univ., N. Y.). Nature (London), 223: 597-8(Aug. 9, 1969).

The outer layers of neutron stars form a solid crust with a calculable rigidity soon after the stars are born. Subsequent changes in stellar shape from oblate towards spherical, as the angular velocity decreases, will induce stresses in the crust, until the maximum shear strain that can be supported is reached. Beyond this yield point a sudden stress relaxation will occur, accompanied by a very small change in stellar shape and moment of inertia. The calculated accompanying jump in angular velocity is close to that observed in a pulsar. Some implications of such a model are discussed, particularly with regard to superdensity matter and Coulomb fields. Because of strong Coulomb repulsion, nuclei become arranged into a bcc lattice with a calculated melting temperature approaching 10^{10}K in the density regime of 10^{12} to 10^{14} g/cm^3, which characterizes most of the crust. The thickness of the solid crust will vary from about 200 m in the heavier neutron stars of about one solar mass or more to most of the stellar radius for a very light star. For parameters appropriate to densities between 5×10^{12} and 5×10^{13} g/cm^3 the shear modulus is around 10^{30} dynes/cm^2, and for a Coulomb lattice far below its melting temperature, the maximum shear strength can depend only on Ze (characteristic nuclear charge), m_z (the numerical density of nuclei), and perhaps the fraction of crystal defects. If pulsars are rotating neutron stars, their angular velocities when formed were greater than observed at present since shorter-period pulsars are slowing down. The crust therefore solidified at a time when centrifugal forces gave a more-oblate shaped star than at present, and neutron stars satisfy criteria for star quakes as they slow down. Shape distortion caused by crust rigidity, although quite small, would give the sudden increase in angular velocity which has been observed for the young short period pulsar PSR 0833-45. (UK)

41825 RAPID RADIO VARIATIONS IN BL Lac. Andrew, B. H. (National Research Council, Ottawa); MacLeod, J. M.; Locke, J. L.; Medd, W. J.; Purton, C. R. Nature (London), 223: 598-9(Aug. 9, 1969).

It is stated that BL Lac (VRO 42.22.01) shows interesting and unusual properties at both radio and optical wavelengths. An extensive set of measurements at 4.5 and 2.8 cm is described, showing that at these wavelengths the source is an exceptionally rapid variable. Measured flux densities are tabulated. At three distinct times during a period of 7 months the intensity rose and fell by a factor of almost 2, and during March 1969 there was an outburst with a timescale of about 25 days and an amplitude of about 3 flux units at 4.5 cm, indicating an increase of about 40%. Other variable radio sources have time scales of several months or even years. It is probable that the source has been undergoing a series of unrelated and perhaps overlapping outbursts. The qualitative features are satisfactorily explained by a model that attributes the variations to adiabatic expansion of the source. It is also indicated that the radius of the variable component is $\lesssim$0.02 pc. (UK)

41826 POSSIBLE DATES OF BIRTH OF PULSARS FROM ANCIENT CHINESE RECORDS. Kiang, T. (Dunsink Observatory, Castleknock, Ireland). Nature (London), 223: 599-601(Aug. 9, 1969).

The pulsar NP 0532 has been identified with the central star of the Crab Nebula, the remnant of the "Chinese" supernova of 1054; there thus appears to be a prima facie case for a systematic search through ancient Chinese records for similar coincidences, but an argument is put forward against such an undertaking, based on an analysis of the data on 22 of the 26 known pulsars, but with particular reference to MP 1727. No clear correlation was found between the pulse period and the inferred date of birth, nor between the period and the duration of the visible event. (UK)

41827 ROTATIONAL EXCITATION OF THE INTERSTELLAR CN MOLECULE. Takayanagi, Kasuo; Itikawa, Yukikazu (Tokyo Univ.). Publ. Astron. Soc. Jap., 20: 376-84(Dec. 1968).

Rotational excitation of the CN molecule by thermal electron impact is studied in a close-coupling method to test the Born approximation previously used. It is found that the Born approximation gives a fairly accurate cross section even for the molecular dipole moment as large as 2.5 debye. The excitation by slow protons is also studied by a semiclassical method. Again, the higher-order processes are taken into account to see the deviation from the first-order perturbation theory. Results of these calculations are applied to the interstellar CN molecules. It is concluded that the observed population in the rotationally excited level cannot be explained in terms of the collisional excitation, unless the molecules are in an H II region of relatively high density. (auth) (NSA of Japan)

41828 A STUDY OF NEUTRAL HYDROGEN ABSORPTION FEATURES OF SOME GALACTIC RADIO SOURCES. Sato, Fumio (Tokyo Univ.). Publ. Astron. Soc. Jap., 20: 303-16 (Dec. 1968).

Absorption features of the 21-cm hydrogen line in the directions of a part of Cygnus X and or W 49 are studied by making use of the Maryland–Green Bank Galactic 21-cm Line Survey, First Edition. Some equal-velocity contour diagrams constructed from the right-ascension scans in these regions are presented. Seven sources in Cygnus X lie in the region of the present investigation. The difference in H I absorption features for each source at some fixed radial velocities, and the variation of these features with radial velocity are examined in relation to the reported hydrogen recombination line measurements. The existence of small irregularities in the distribution of the H I gas in this region is inferred from the present analysis. For the source W 49, at a radial velocity around +12 km/sec, a large-scale structure of H I gas was found which causes a strong absorption on component A but hardly on component B. This may indicate that component A lies beyond this H I structure, while component B lies in front of it. This large-scale structure may be considered as part of a spiral arm at a distance of about 14 kpc. Thus, it may be concluded that the two components in the source W 49 are not a physically related double source, but are detached from each other in the line of sight. (NSA of Japan)

41829 CIRCULAR POLARIZATION MEASUREMENTS OF COMPACT RADIO SOURCES AT 1420 MHz. Seielstad, G. A. (Owens Valley Radio Obserberatory, Big Pine, Calif.). Astron. Astrophys., 372-4(July 1969).

The circular polarization of seventeen small-diameter radio sources was measured at a frequency of 1420 MHz. None had detectable polarization, although for some sources independent measurements made at different frequencies agreed as to the sense of circular polarization. (auth)

41830 HYDROMAGNETIC PLASMA ACCELERATION BY RAPIDLY ROTATING ASTROPHYSICAL OBJECTS. Michel, F. Curtis (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 23: 247-9(Aug. 4, 1969).

The acceleration of plasma away from a rotating magnetized object was solved for analytically. Application of that analysis to rotator models for the radio, optical, and x-ray pulsar NP 0532 suggests that it has a magnetic moment of order 3×10^{30} G cm^3 and is losing mass at a rate of 2×10^{9} g/sec. These parameters would provide particles in excess of 10^{11} eV and a 6×10^{-4}-G field in the Crab Nebula at 1 lt yr from NP 0532. (auth)

41831 PULSAR SEARCH TECHNIQUES. Burns, W. R.; Clark, B. G. Astron. Astrophys., 2: 280-7(July 1969).

Pulsar search signal processing is discussed. A description of the digital techniques currently used by groups connected with the Arecibo Ionospheric Observatory, the Harvard College Observatory, the University of Massachusetts, and the National Radio Astronomy Observatory is given. These techniques all make use of either a fast-folding (cross-correlation) algorithm (FFA) or a fast Fourier transform (FFT) algorithm. They are investigated from the point of view of both signal-to-noise ratio and the processing time required. Additional techniques are also suggested and analyzed. A statistical distribution on pulse amplitudes is considered and its effect on the described processes examined. Techniques which do not rely on the fundamental periodic nature of the signal are considered. Specific examples are examined and the standard techniques discussed in light of the examples. (auth)

41832 THE ARIEL III COSMIC RADIO NOISE EXPERIMENT. Smith, F. G.; Gregory, P. C. (Jodrell Bank Observatory, Macclesfield, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 517-25 (Aug. 12, 1969).

It is stated that perhaps the most important result of the radioastronomical experiment in Ariel II was the measurement of the extragalactic component of the background radiation, not only because of the radiation processes themselves but because of the galactic absorption which is evident at frequencies below about 3 MHz. With Ariel III it may be possible to measure accurately the background radiation over the range 2 to 4 MHz and to show the onset of the absorption. The radio noise generated in the ionosphere, which was investigated very successfully by Ariel II, has so far only been detected with electric dipoles. With Ariel III it is possible that a value for the small H field in the noise bands may be obtained. Some experimental difficulties are, however, described. (UK)

41833 ARE QUASI-STELLAR RADIO SOURCES GIANT PULSARS. Morrison, P. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 157: L73-6(Aug. 1969).

Quasi-stellar sources are analogues to pulsars in every respect save that of scale, even exhibiting regular optical pulses. It is proposed that their common feature is a central, magnetized, spinning, condensed mass, whose luminous lifetime is governed by the rotational work done on charged particles by the moving magnetic field. The properties of the model are tabulated. (auth)

41834 ENERGY SPECTRUM AND TIME VARIATION OF SCO X-1. Rao, U. R.; Jayanthi, U. B.; Prakasarao, A. S. (Physical Research Lab., Ahmedabad, India). Astrophys. J., 157: L133-7 (Aug. 1969).

Two rocket flights carrying x-ray payloads were conducted from Thumba Equatorial Rocket Launching Station (TERLS), Trivandrum, India, on November 3 and 7, 1968, respectively. The energy spectrum of Sco X-1 observed during both flights in the energy range 2 to 20 keV is presented. A comparison of the results with previous observations indicates that the flux of Sco X-1 exponentially decreased over the period 1965–1968 with a time constant of about 4.1 years. (auth)

41835 X-RAY FLUX FROM CENTAURUS X-2 IN THE ENERGY RANGE 2 TO 20 keV. Rao, U. R.; Chitnis, E. V.; Prakasarao, A. S.; Jayanthi, U. B. (Physical Research Lab., Ahmedabad, India). Astrophys. J., 157: L127-32(Aug. 1969).

Two rocket flights carrying x-ray payloads were conducted from Thumba Equatorial Rocket Launching Station (TERLS), Trivandrum, India, on November 3, 1968, and November 7, 1968, respectively. The first evidence for the existence of low-energy x-ray flux in the energy range 2 to 20 keV from the Cen X-2 source since its reported extinction in May 1967 is presented. The observed flux has the same energy spectrum as that observed in the high-energy range by Lewin et al., in October 1967. (auth)

41836 ARE SOME QUASI-STELLAR OBJECTS ASSOCIATED WITH CLUSTERS OF GALAXIES. Bahcall, John N. (California Inst. of Tech., Pasadena); Schmidt, Maarten; Gunn, James E. Astrophys. J., 157: L77-9(Aug. 1969).

Five small-redshift quasi-stellar objects are listed that are within the approximate geometrical boundaries of cataloged clusters of galaxies. Spectra of four galaxies in one of the clusters show the same redshift as the associated quasi-stellar object B264. (auth)

41837 THREE RADIO SOURCES WITH UNUSUAL INTENSITY VARIATIONS. Locke, J. L.; Andrew, B. H.; Medd, W. J. (National Research Council, Ottawa). Astrophys. J., 157: L81-6 (Aug. 1969).

Variations in flux density of three sources (PKS 1510–08, PKS 0736 + 01, and NRAO 512) were observed at 2.8- and 4.6-cm wavelengths. The variations are unusually rapid. It is suggested that the observed variations are caused by the prolonged injection of relativistic particles into a source which remains optically thin. The sources can be placed at cosmological distances only if the magnetic-field strength in the variable component is less than

10^{-6} gauss or if relativistic effects play an important part in the evolution of the sources. (auth)

41838 PUMPING MECHANISM FOR ANOMALOUS MICROWAVE ABSORPTION IN FORMALDEHYDE IN INTERSTELLAR SPACE. Townes, C. H.; Cheung, A. C. (Univ. of California, Berkeley). Astrophys. J., 157: L103-8(Aug. 1969).

A pumping mechanism which produces an excess population in the lower state 1_{11} of H_2CO by molecular collisions is proposed. Calculation on the basis of a simplified model agrees reasonably well with the observed absorption at 4830 MHz by H_2CO of the 2.8°K isotropic radiation reported by Palmer and coworkers. Implications of various transition rates and column densities related to the observed H_2CO absorption are discussed. (auth)

41839 OBSERVATIONS OF THE $^2\Pi_{1/2}$, J = $5/2$ EXCITED STATE OF OH IN W3. Schwartz, P. R.; Barrett, A. H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 157: L109-10(Aug. 1969).

The F = 2 → 2 line of the $^2\Pi_{1/2}$, J = $5/2$ state of OH was detected in W3. The other three lines of this state could not be detected. (auth)

Solar Phenomena

Refer also to abstracts 41064, 41068, 41998, 41999, 42003, 42064, 42073, 42640, and 42748.

41840 ON THE NATURE OF THE HIGH-FREQUENCY CUTOFFS OF TYPE-IV SOLAR RADIO BURSTS. Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. Lett., 4: 43-5(Aug. 1969).

The high-frequency cutoff of synchrotron radiation resulting from electrons with an anisotropic pitch-angle distribution was investigated. It is shown that this effect could be responsible for the high-frequency cutoffs of Type-IV bursts at decimeter, meter, and decameter wavelengths. (auth)

41841 TURBULENT VELOCITIES AND THE STRUCTURE OF QUIESCENT PROMINENCES. Kiryukhina, A. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 49-54(July-Aug. 1969).

Translated from Astron. Zh., 46: 66-73(Jan.-Feb. 1969).

The results of a reduction of the spectra of quiescent prominences having bright metal lines are discussed. The presence of structure in various prominences is established. A bright prominence usually comprises several filaments with different radial velocities but with the same physical conditions. Inside the filaments the kinetic temperature T = 6000 ± 1000°K and the turbulent velocity v = 2.5 to 3 km/sec. A neglect of the structure of prominences will lead to an underestimate of T, an overestimate of v, and an inference that regions with different physical conditions exist in a prominence. (auth)

41842 EQUIVALENT LINE WIDTHS IN SUNSPOTS. Teplitskaya, R. B.; Turchina, V. D. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Sov. Astron. AJ (Engl. Transl.), 13: 55-63(July-Aug. 1969).

Translated from Astron. Zh., 46: 74-84(Jan.-Feb. 1969).

Theoretical curves of growth for the Fe I, Fe II, Ti I, and Ti II at several points on the solar disk are computed for five sunspot umbra models. The shape of these curves differs from that of the photospheric curve of growth, particularly for the ionic lines. The excitation temperature determined from the curve of growth is shown to depend on the excitation potential of the atoms in question and on the position of the sunspot on the solar disk, but it is difficult to check these relationships observationally with the currently available accuracy of measurement. Theoretical intensification curves are computed for all the models. It is stressed that weak ionic lines of various elements should actually be present in the umbra spectrum. Cation should therefore be exercised when selecting appropriate lines by Howard's method in order to eliminate scattered light. The results of Fricke and Elsässer's equivalent-width measurements can be interpreted if the Fe I, Fe II, Ti I, and Ti II lines are formed in a dense sunspot with a hydrostatic pressure distribution. A sunspot model is proposed with properties intermediate between those of Zwaan's and Mattig's models. The scattered light distorting the photometric measurements of the sunspot spectrum arises to a large extent from penumbral radiation. (auth)

41843 AN ANALYSIS OF HYDROGEN-LINE PROFILES BROADENED BY THE STARK AND DOPPLER EFFECTS. Kurochka, L. N. (Kiev Univ. Observatory). Sov. Astron. AJ (Engl. Transl.), 13: 64-72(July-Aug. 1969).

Translated from Astron. Zh., 46: 85-96(Jan.-Feb. 1969).

The broadening of the Balmer lines by the Stark and Doppler effects is investigated. Tables present halfwidths of the Balmer lines for various values of the electron concentration and the Doppler width. The behavior of the halfwidth curves is discussed for the case where the lines are subject to self-absorption. The electron concentration in prominences ($\approx 5 \cdot 10^{10}$ cm^{-3}) and in the chromosphere ($\approx 10^{11}$cm^{-3}) is determined from the halfwidths and the number of the last resolvable Balmer line. (auth)

41844 THE NATURE OF THE SUN'S DIFFERENTIAL ROTATION. Iroshnikov, R. S. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 73-82(July-Aug. 1969).

Translated from Astron. Zh., 46: 97-112(Jan.-Feb. 1969).

An analysis is made of the influence on the rotation of the Sun's convection zone of its strongly quasikinetic character, due to the fact that the "mean free path" of the convection elements is comparable to the scale height of the atmosphere. Allowance must be made for the effect exerted by the rotation on the viscosity tensor by means of centrifugal forces; this in turn influences the rotation law. Solutions are sought by iteration in powers of the angular velocity ω, regarded as a small parameter (up to order ω^3); the convection layer is moreover assumed to be thin. In the first approximation differential rotation with respect to latitude is absent not only in the continuous-medium formulation but also in the kinetic approach. Arguments are advanced indicating that in the second approximation the distortion of the viscosity tensor by the rotation reduces primarily to an appearance of nondiagonal tensor components "located" in the meridional plane. The latitudinal differential rotation is shown to be governed not only by the influence of the meridional circulation on the radial gradient in the angular velocity, but also by the influence of the distorted viscosity tensor on the radial, and particularly on the latitudinal gradient. The predominance of the latter effect causes the latitudinal differential rotation law (normalized, say, to the equator) to be the same at all depths in the convection zone. A graphic interpretation of this this result is given. For the Sun, agreement with the observations is obtained if the viscosity tensor is "flattened" along the vertical so that $\partial\omega/\partial r > 0$. It would appear that the Sun's convection zone is considerably thinner than previously believed, possibly ending immediately beneath the supergranulation structure. (auth)

41845 SOLAR RADIATION PRESSURE ON PARTICLES OF INTERPLANETARY DUST. Gindilis, L. M.; Divari, N. B.; Reznova, L. V. (Shternberg Astronomical Inst., Moscow. Odessa Polytechnical Inst.). Sov. Astron. AJ (Engl. Transl.), 13: 114-19(July-Aug. 1969).

Translated from Astron. Zh., 46: 152-8(Jan.-Feb. 1969).

Results of a calculation of the factors affecting the effectiveness with which solar radiation pressure acts on spherical particles of various substances and a calculation of the force exerted by solar radiation pressure on particles of interplanetary dust as a function of their radius and density are presented. The particle parameters at which solar radiation pressure exceeds the gravitational attraction of the Sun are evaluated. It is concluded that the micron and submicron components of interplanetary dust must primarily consist of comparatively dense (dielectric and absorbing) particles of an asteroidal origin. For particle dimensions of the order of several microns or larger, as well as for very small dimensions, interplanetary space must contain less dense particles of cometary origin in addition to the asteroidal particles. Absorbing particles with radii less than 0.1 to 0.5 μ cannot be present in the interplanetary dust. (auth)

41846 AGE OF THE ELEMENTS AND THE r-PROCESS IN THE SOLAR SYSTEM. Levskii, L. K.; Morozova, I. M. Sov. Astron. AJ (Engl. Transl.), 13: 91-3(July-Aug. 1969).

Translated from Astron. Zh., 46: 123-5(Jan.-Feb. 1969).

In addition to the uranium, thorium, and osmium–rhenium cosmochronologies, a rubidium–strontium chronology is considered. The consistency of the different cosmochronologies determines an age of $(10.7 \pm 0.5) \times 10^9$ yr for the elements. The proposal of a local increase in the intensity of the r process (up to 15% of the galactic intensity) is admissible and does not conflict with existing cosmochronologies. (auth)

41847 LOW-NOISE SOLAR AND LABORATORY SPECTROSCOPY. IV. A TECHNIQUE FOR RELATIVE OSCILLATOR STRENGTH MEASUREMENT WITH APPLICATIONS TO Fe I. Peach, J. V. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc., 144: 171-7(1969).

A King furnace absorption source is described for use with the Oxford spectrometer in relative oscillator strength measurement. Experiments on lines of Fe I indicated that high inert-gas pressures in the source, combined with direct integrations of very faint line profiles, can increase the precision of relative oscillator strength measurement by this method and enable its use to be extended to lines of higher excitation potential than has hitherto proved possible. (auth) (UK)

41848 RIOMETER MEASUREMENTS, SOLAR PROTON INTENSITIES, AND RADIATION DOSE RATES. Juday, Richard D. (Manned Spacecraft Center, Houston, Tex.); Adams, G. W. Planet. Space Sci., 17: 1313-18(June 1969).

In the course of the development of a solar proton monitoring system utilizing ground-based equipment, several numerical relationships were found which minimize the need to know the spectral forms in relating daytime polar-cap riometer measurements, particle intensities, and dose rates. It is shown that, to a good approximation, one can start with riometer absorption as a function of time, calculate the intensity of protons with energies greater than 11 MeV vs. time, calculate hard-spectrum and soft-spectrum limits to the proton energy spectrum versus time, and finally determine upper and lower limits to the radiation dosage for the event. (UK)

41849 DEPENDENCE OF THE LUNAR WAKE ON SOLAR WIND PLASMA CHARACTERISTICS. Ogilvie, K. W.; Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 4123-8(Aug. 1, 1969).

Simultaneous measurements in cislunar space of the characteristics of the solar wind plasma as observed by Explorer 34, and the perturbed magnetic field in the lunar wake as detected by Explorer 35, were performed during July–October 1967. The plasma parameter β_i for the ions is found to be more important in determining the magnitude of the umbral positive and penumbral negative anomalies than the direction of the interplanetary magnetic field. A quantitative comparison of these observations with the lunar wake theory of Whang indicates that the solar-wind electrons must contribute even more significantly than the ions to the effective β for the plasma. Using the lunar wake as a solar wind sock for the electrons yields $\beta_e \sim 2\beta_i$, so that on the average the temperature of the electrons is indirectly determined to be $T_e/T_i \approx 2$ and the net effective β of the plasma is $\sim 3\beta_i$. (auth)

41850 SOLAR-CYCLE VARIATION OF EXTREME ULTRAVIOLET RADIATION. Hall, L. A.; Higgins, James E.; Chagnon, C. W.; Hinteregger, H. E. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 74: 4181-3(Aug. 1, 1969).

Since 1959 measurements have been made of solar extreme ultraviolet radiation from Aerobee rockets carrying a grazing-incidence grating spectrometer mounted on a biaxial solar pointing control. Photoelectric detection was employed, and in all cases the measurement made was of the integrated radiation from the total solar disk under nonflare conditions. Some of the results have been presented in previous papers, and some are presented here for the first time. (W.D.M.)

41851 THE RELATIONSHIP BETWEEN VARIATIONS OF SOLAR CORPUSCULAR AND ULTRA-VIOLET RADIATION AND THE INTENSITY OF THE MID-LATITUDE AIRGLOW IN THE OI LINE (λ 5577A). Shapiro, Ralph (Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci., 17: 1323-4(June 1969).

No significant association was found between solar corpuscular radiation and airglow intensity (ISSFF) which is independent of the formation contained in either the Zurich Sunspot Number or the intensity of the F2-layer critical frequency indices of solar ultraviolet radiation. Also, the association between indices of solar ultra-violet emission and ISSFF appears to exist only for variations on a time scale of the order of the sunspot cycle and not for short-term variations. (UK)

41852 EFFECTIVE GAUNT FACTORS g_{eff} FOR EXCITATION OF POSITIVE IONS BY ELECTRON COLLISIONS IN A SIMPLIFIED COULOMB-BORN APPROXIMATION. Blaha, M. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 157: 473-7 (July 1969).

Effective Gaunt factors g_{eff} were calculated for threshold excitation of positive ions by electrons for transitions in fifteen isoelectronic sequences. A simplified Coulomb–Born approximation was used, the validity of which is given by an inequality. Results are presented as a function of Z/k, where $\frac{1}{2}k^2$ is the excitation energy in atomic units. (auth)

41853 INTERCOMBINATION OSCILLATOR STRENGTHS IN THE HELIUM SEQUENCE. Drake, G. W. F.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J., 157: 459-62(July 1969).

The electric dipole oscillator strengths and transition probabilities of the spin-forbidden transitions among the 1^1S, 2^1S, 2^1P, and 2^3P levels of the heliumlike ions from He I to Ne IX are evaluated to high accuracy by purely theoretical methods. (auth)

41854 ACCELERATION OF CHARGED PARTICLES IN THE INTERPLANETARY PLASMA. Kats, M. E.; Yukhimuk, A. K. (Inst. of Geophysics, Kiev). Ukr. Fiz. Zh., 14: 1019-22(June 1969). (In Russian).

The nature is discussed of the second peak of fast protons which appears after coming of a diffusive wave from a solar flare. The presence of the fast proton peak is connected with acceleration of particles by fluctuation fields in the interplanetary plasma. (auth)

41855 MODEL OF SUNSPOT UMBRA. Henoux, J. C. (Observatoire, Meudon, France). Astron. Astrophys., 2: 288-308 (July 1969). (In French).

In a preceding paper (Hénoux, 1968) the temperature of a large umbra ($A_u > 100 \times 10^{-6}$ Hem.) was determined in the layers deeper than $\tau_0 = 0.3$. The temperature structure was deduced from measurements of infrared relative umbral intensities, with an estimated accuracy of 60°K. In this paper another large umbra observed on 9/21/69 is studied. The study of profiles and equivalent widths of strong, medium, or weak atomic lines, in the visible spectral region, permits a study of the temperature structure to higher layers and to show that umbra is in hydrostatic equilibrium. It is supposed that umbras of large areas ($A > 100 \times 10^{-6}$ Hem.) have the same temperature, as that previously determined for $\tau_0 > 0.3$. (auth)

41856 STUDY OF THE CORRELATION BETWEEN FLARES AND THE EVOLUTION OF MAGNETIC FIELD. Ribes, E. (Observatoire, Meudon, France). Astron. Astrophys., 2: 316-21 (July 1969).

The longitudinal field of the active region (230°L, 20°b) was observed. With a good sequence of observations, no observational evidence was found that the variations of the total south and north fluxes are correlated with a flare. In return, a law was found which seems to rule the evolution of the magnetic features involved in flares. This evolution rule is the following: two adjacent opposite polarity features may be associated with flares if their magnetic fluxes are evolving in opposite senses, one growing, the other diminishing. The reciprocity rule is demonstrated. (auth)

41857 THE APPLICATION OF DIMENSIONAL ANALYSIS TO PROBLEMS OF THE MOTION OF INTERPLANETARY GAS DURING SOLAR FLARES. Korobeinikov, V. P. (Mathematics Inst., Moscow). Dokl. Akad. Nauk SSSR, 185: 1254-7(Apr. 21, 1969). (In Russian).

Solar flares take place in a relatively small area of 0.1% of the solar disk, develop within a time of 300 to 4000 sec, and give off an energy of 10^{29} to 10^{35} ergs. A hydrodynamic approximation in dimensionless terms is used to describe the flow of the interplanetary gas for different flare energies and times. The gas flow is assumed to be spherically symmetric. The flow then depends only on the dimensionless variables of relative distance from the Sun and relative time. The relative distance from the Sun is plotted as a function of flare energy. The calculations show that for most flare energies the value of the relative distance is greater than an astronomical unit (1.5×10^{13} cm). Experimental data for one energy of solar flare can be extrapolated to a different energy of solar flare by using dimensionless variables and the assumption of spherical symmetry. (TTT)

41858 SOLAR ACTIVITY, BIOGENESIS, AND EXTINCTIONS. Dauvillier, A. (Observatoire du Pic du Midi, Bagneres, France). Scientia (Milan), 103: 551-68(Nov.-Dec. 1968). (In French).

The history of the Sun is postulated, using other stars as models. Cycles of 11, 22, 80, and perhaps 400 years in solar activity have been noted. Calculations suggest that the Sun has converted 6% of its H into He; increased radiation for 12 billion years, followed by the formation of a supernova, has been predicted. Calculations such as these and the neutrino flux at the Earth's surface are based on the invariability of the fundamental constants, a point which has been argued. The age of the Universe is based on the expansion of space, a tenet which is not necessarily valid. Models for the stability of solar radiation in the past might include Krueger 60 and UV Ceti, stars whose intensity increased by factors of 6 and 250 within minutes and then died back quasi-exponentially. The periodic disturbance by conjunction of Jupiter and Saturn occurring every 20 years is considered; this is added to the residual oscillation of the Sun after the ejection of Mercury. Proton currents follow, as on February 23, 1956, a rapid increase in minutes by a factor of 500, followed by quasi-exponential decay. These could be accumulated in an instability in the Sun with a period of 10^5 yrs at the present, with increasing period, responsible for glaciation, and eventually the source of the extinction of life on the earth. (BBB)

41859 THE MAGNETOHYDRODYNAMIC MECHANISM OF SOLAR ACTIVITY. Dauvillier, Alexandre (College de France, Paris). Rev. Gen. Elec., 78: 241-50(Mar. 1969). (In French).

A new attempt to explain the origin of solar magnetic fields, x rays, radio waves, and cosmic rays is made. It is based on the magnetohydrodynamic properties of the electric arc and developed by analogy to problems of electrotechnology. Differential rotation is taken as the source of activity; this may be maintained by synchronization to the resonance of a photospheric oscillation on the period of rotation by the effect of planetary tides. These tides modulate activity with a period of 11 yr. The toroidal field is concentrated and expelled from the photosphere by vortices due to Coriolis forces. The field is maintained by disruptive discharges constituting granulation. The mechanism may be extended to the magnetic stars of Babcock, where known or unknown companions produce tides; the fields of these are the result of a different process from those of the Sun. (BBB)

41860 MODEL FOR COMET-SOLAR WIND INTERACTION. Shelby, M. E. (Univ. of Houston, Tex.). Planet. Space Sci., 17: 1413-23(July 1969).

The size and shape of the contact discontinuity around a comet's nucleus are found, based on the assumption that the ions moving away from the nucleus are noninteracting and that these ions are specularly reflected by the solar wind's frozen-in magnetic field. By superimposing the density due to the ions flowing directly from the nucleus and the specularly reflected ions, contours of constant density inside the cavity are obtained. It is found that the calculated size and shape of the cavity agree with observational data and that certain of the anomalous plasma formations (clouds, rays) found in type I tails may be explainable by the model. (auth) (UK)

41861 THERMOMETRY OF THE SUN'S INTERIOR IN NEUTRINO DETECTION EXPERIMENTS. Kuz'min, V. A. Kosm. Luchi, No. 10, 81-3(1969). (In Russian).

The possibilities are considered of the thermometry of the solar interiors with the radiochemical ^{37}Cl, ^{71}Ga, and ^{7}Li methods of solar neutrino detection and the relevant uncertainties are discussed. The possibilities are examined whether the results of the Davis experiment can be interpreted in terms of the upper limit of the central temperature of the sun. (auth)

41862 RESONANCE-BROADENING ABSORPTION IN THE WINGS OF LYMAN ALPHA. Sando, K.; Doyle, R. O.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 157: L143-5(Aug. 1969).

It is pointed out that the conventional formula describing absorption in the wings of Lyman alpha seriously overestimates the magnitude of the absorption at long wavelengths, and it seems improbable that the resonance-broadened wings of Lyman alpha are a significant source of opacity at wavelengths in excess of 2000 Å. (auth)

41863 OBSERVATIONS OF TWO COMPONENTS IN ENERGETIC SOLAR X-RAY BURSTS. Kane, S. R. (Univ. of California, Berkeley). Astrophys. J., 157: L139-42(Aug. 1969).

Measurements made with the solar x-ray detector aboard the OGO-5 satellite show that some energetic ($\gtrsim$9.6 keV) solar x-ray bursts consist of two components, viz., (1) an impulsive component that reaches its peak early in the event approximately in coincidence with the peak in the microwave burst and has a photon spectrum consistent with a power law in energy and (2) a slower component that attains its maximum later in the event and has a photon spectrum steeper than that for the impulsive component. The measurements also show that in some x-ray bursts only the slower component is observable. The impulsive component is attributed to the bremsstrahlung emission from electrons with a nonthermal energy distribution. (auth)

Galaxies

41864 INTERSTELLAR HYDROGEN ATOMS ON GRAPHITE GRAINS. McIntyre, H. A. J. (Univ. of Salford, Eng.); Williams, D. A. Nature (London), 223: 487-8(Aug. 2, 1969).

It has been suggested (Duley, Nature, 222 : 361 (1969)) that the cause of the deficiency of stellar uv flux below the Lyman-α line may be due to H atoms near interstellar grains absorbing at wavelengths shifted from 1216 Å to shorter wavelengths. Whereas Duley assumed the grains to be pure dielectric in his calculations of shifts, it is pointed out that the material of interstellar grains is usually assumed to be graphite, which in many respects behaves more as a metal than a dielectric. Using results for metals, the present authors calculated the energy shifts in the 1s and 2p states of an H atom at various distances from a plane graphite surface, treated as a metal. It appeared from the results that if an H atom is associated with a graphite grain which retains appreciable crystal structure, the resonance line is shifted to wavelengths > 1216 Å; this effect is opposite to that found for Duley for pure dielectric grains. (UK)

41865 SPECTROPHOTOMETRY OF THE NUCLEUS OF THE GALAXY NGC 3031. Alloin, Danielle; Andrillat, Yvette (Observatoire, Meudon, France. Laboratoire d'Astronomie, Herault, France). Compt. Rend., Ser. B, 268: 1397-1400(May 28, 1969). (In French).

In this note, the optical spectra of the nucleus of the galaxy NGC 3031, emission and absorption lines as well as the continuum, are described, the object being a theoretical interpretation. (tr-auth)

41866 THE TEMPERATURE AND INTERNAL KINEMATICS OF M8. Foukal, Peter (Univ. of Manchester, Eng.). Astrophys. Space Sci., 4: 127-42(June 1969).

A photoelectric Fabry–Pérot spectrometer was used to record the line profiles of Hα and [N II] at 22 points in the nebula. The ratio of intensity Hα/[N II] was used to derive an electron temperature distribution with values between 5700 and 9100° showing a peak at the center of density. These temperatures were compared with the Hα Doppler temperatures to estimate excess velocities of mass motion. Together with the shifts of the Hα line centers, these lead to an evaluation of the velocity field in the nebula. It is suggested that the nebula consists of a core expanding at about ±10 km/sec surrounded by a thick peripheral shell in which large-scale mass motions are small. Nonthermal broadening suggesting turbulent velocities at about the speed of sound is observed in this shell and is attributed to small-scale dynamic effects in a nonsmooth density distribution. The effect of such expanding cores on heliocentric velocities of galactic H II regions is discussed. (auth)

41867 SEARCH FOR A NEUTRAL-ATOMIC-HYDROGEN LINK BETWEEN M31 AND M33. Gordon, K. J. (Univ. of Michigan, Ann Arbor. National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett., 4: 47-9(Aug. 1969).

An upper limit of 5×10^{19} atoms cm^{-2} is established for the projected surface density of neutral atomic hydrogen between the galaxies M31 and M33. (auth)

41868 CALCULATED Fe X AND Fe XIV LINE STRENGTHS IN A SEYFERT GALAXY MODEL. Osterbrock, D. E. (University Coll., London). Astrophys. Lett., 4: 57-9(Aug. 1969).

The photoionization model of Williams and Weymann is extended to calculate approximately the sizes of the zones that emit [Fe X] λ6374 and [Fe XIV] λ5303, their temperatures, and luminosities. Excitation by resonance fluorescence is important, particularly for λ5303. The calculated strengths of λ6374 and λ5303 are close to but below the observed values. (auth)

41869 INTERSTELLAR GRAINS. Hoyle, F.; Wickramasinghe, N. C. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London), 223: 459-62(Aug. 1969).

Interstellar grains may be a mixture of graphite particles formed in carbon stars and of silicates in oxygen-rich giants. The astrophysical consequences of such a grain mixture are examined. (auth) (UK)

41870 LOW-ENERGY COSMIC RAYS AND PLASMA TURBULENCE. Pikel'ner, S. B.; Tsytovich, V. N. (Shternberg Astronomical Inst., Moscow. Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 13: 5-14(July-Aug. 1969).

Translated from Astron. Zh., 46: 8-19(Jan.-Feb. 1969).

A discussion is given of the problem of the acceleration and isotropization of the low-energy cosmic rays responsible for heating and ionizing the interstellar gas. Acceleration by Langmuir waves depends on the spectrum of the turbulence. A decreasing power spectrum prevails in the wave-number range $k < k_* = \omega_{0e} v_{t,i}/3v_{t,e}^2$, while the spectrum is nearly horizontal in the range $k > k_*$. If there is a low level of turbulence the energy for $k \gtrsim k_*$ will be relatively small. The acceleration of electrons is considerably more efficient than the acceleration of protons of the same velocity. Hence acceleration of protons cannot take place throughout interstellar space, for otherwise the electrons knocked out of atoms by the protons would be accelerated and would accumulate, diminishing the level of turbulence. The acceleration evidently occurs in individual active regions, not in the main part of the Galaxy, where the level of turbulence is lower than needed to accelerate electrons. As an example of the active regions, the acceleration due to shock waves in supernova envelopes of radius 20 to 30 psc is calculated. Envelopes of this kind could supply some acceleration but their total energy would hardly suffice even under favorable conditions. Other active regions might also exist, such as the galactic center. The circumstances of the acceleration imply that the subcosmic rays heating the gas should be protons rather than electrons. The high-energy electrons responsible for the radio emission of the Galaxy might be generated in sources having strong Langmuir turbulence; their power spectrum would result from the direct and inverse Compton effect for plasma waves. (auth)

41871 DEFECTS IN INTERSTELLAR GRAINS. Wolstencroft, R. D.; Ireland, J. G.; Nandy, K.; Seddon, H. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc., 144: 245-54(1969).

The production of grains with a high defect concentration in circumstellar and interstellar space as a result of bombardment by energetic particles and photons is discussed. The fraction of all grains which are defective depends on the assumed lifetime of the grains. For a minimum lifetime ~10^8 year a minimum of 1% of all grains will be defective. The defects influence the optical properties of the grains and in particular may be responsible for the diffuse interstellar bands and certain features of the extinction curve. (auth) (UK)

41872 RADIO-FREQUENCY OBSERVATIONS OF THE EDGE-ON SPIRAL GALAXY NGC 4631. Pooley, G. G. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 143-50 (1969).

High-resolution observations of NGC 4631 at 408 and 1407 MHz show that the nonthermal radio emission originates in a narrow equatorial region less than 700 pc thick. The bright emission nebulae coincide with minima in the radio emission. No radio halo or spurs were detected. If a halo is present it must contribute less than 10% of the total radio luminosity of the galaxy. (auth) (UK)

41873 THE DISTRIBUTION OF MATTER IN THE BOK GLOBULES IN THE ORION NEBULA. Penston, M. V. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 159-70(1969).

The Bok globules in the Orion nebula were studied and curves of optical depth against projected radius obtained in two colours. From these, the temperature and density of the material in the globules were deduced. The masses of the globules were found to be of the order of a solar mass and the temperature to have low values (~10°K). The color dependence of the absorption was also found. (auth) (UK)

41874 THE HARTREE-FOCK EXCHANGE OPERATOR AND THE STABILITY OF GALAXIES. Lynden-Bell, D. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc., 144: 189-217(1969).

A new general method is invented for analyzing the stability of stellar systems. A variational principle that only concerns the perturbation potential is developed in terms of an operator similar to those found in the theory of atomic structure. In many cases it is shown that a stellar system is stable if, and only if, this operator is positive definite. (auth) (UK)

41875 ELLIPSOIDAL VELOCITY OF H II REGIONS IN M33. Brosche, P. (Astronomisches Rechen-Institut, Heidelberg). Astrophys. Space Sci., 4: 327-9(July 1969). (In German).

The peculiar radical velocities of H II regions in M33 varies with position angle in a manner that can be explained by an ellipsoidal distribution with minor axis in the direction of rotation. The amplitude of the variations, however, is too great as compared with theory or experience in the galaxy. (auth)

41876 HYPOTHESIS OF THE ORIGIN OF THE SPIRAL STRUCTURE OF THE GALAXIES. Marochnik, L. S.; Suchkow, A. A. (Astrophysical Inst., Dushanbe, USSR). Astrophys. Space Sci., 4: 317-26(July 1969).

The spiral waves in a model galaxy consisting of differentially rotating and nonrotating subsystems are considered on the basis of participating phenomena. The subsystems involved represent the Populations I and II of normal spirals, respectively. The spiral waves in such systems are unstable in the Landau sense. Due to this instability they grow up to attain finite amplitude. This growth is stopped by a nonlinear effect (the quasilinear effect), the steady state with waves of finite amplitude being established. The hypothesis is proposed that these waves should be identified with the spiral structure of the galaxies. (auth)

41877 DIRECTION OF THE NEARBY GALACTIC MAGNETIC FIELD INFERRED FROM A COSMIC-RAY DIURNAL ANISOTROPY. Schatten, Kenneth H.; Wilcox, John M. (Univ. of California, Berkeley). J. Geophys. Res., 74: 4157-61(Aug. 1, 1969).

A twenty-year wave in the diurnal anisotropy component of galactic cosmic rays arriving at the Earth from the asymptotic direction 128°E of the Sun has been found by Forbush. This wave is interpreted in terms of enhanced magnetic reconnection between the nearby galactic field and the field lines in the polar regions of the heliosphere during one-half of the twenty-year solar magnetic cycle. This interpretation leads to the result that the component parallel to the solar rotation axis of the nearby galactic field is directed northward. (auth)

41878 SPECTROSCOPIC STUDY OF THE STELLAR CONTENT OF ELLIPTICAL GALAXIES. Moore, Elliott Paul. Tucson, Ariz., Univ. of Arizona, 1968. 93p.
Thesis.

Models of the stellar content of the nuclei of elliptical galaxies are constructed to find the range of initial luminosity function and age consistent with observations. The assumptions include: (1) only a single generation of stars exist, (2) the initial mass function and initial luminosity function are approximated by a power law with variable exponent, and (3) color magnitude diagrams at two ages can be based on the old metal-rich clusters NGC 188 and M67. Mass to light ratios and equivalent widths of thirteen spectral features are synthesized for each choice of initial luminosity function and one of two ages. A comparison of results from the models is made with observations of the ellipticals NGC 221, 3379, 4472, and of the SO NGC 3115. The basic conclusions are: (1) the initial luminosity function deduced from observations of the galaxy satisfactorily represents the equivalent widths of spectral features in elliptical galaxies. Dwarf enrichment is not likely for all four galaxies, but dwarf depletion may occur in the nuclei of the intermediate mass NGC 3379 and giant NGC 4472. M/L ratios support the depletion hypothesis. (2) the light in all four galaxies appears to arise from aggregates younger than NGC 188. Three of the four galaxies are well represented by light from a cluster like M67 augmented by M giants; the SO NGC 3115 appears to require a younger model. (Diss. Abstr.)

41879 OPTICAL STUDY OF NEARBY GALAXIES. Ables, Harold Dwayne. Austin, Tex., Univ. of Texas, 1968. 299p.
Thesis.

Detailed photometric parameters describing the luminosity distribution in six galaxies, NGC 1569, NGC 6946, IC 342, IC 356, IC 1613, and A 1009 (Sex A), are derived from photographic and electrographic isophotometry with photoelectric calibrations. The study of NGC 1569 is one of the first based on exposures with an electronic camera. Distances to each of the galaxies are derived from one or more of the following criteria: magnitudes of the brightest stars, diameters of the largest HII regions and rings, "face-on" diameters, effective diameters, and supernovae. The derived distances place IC 342 and A 1009 within the Local Group of galaxies. IC 342 is the third giant member of the Local Group and is approximately equal to the Galaxy in size and brightness. The distance to NGC 1569 indicates that it is probably a member of the Ursa Major—Camelopardalis Cloud of galaxies. NGC 6946 and IC 356 appear to be isolated galaxies not associated with recognized groups. The effective and intrinsic optical parameters for each galaxy are compared with the corresponding parameters for other galaxies of similar morphological type. The comparison indicates that IC 1613 and A 1009 may represent a separate class of Magellanic irregular galaxies with very low surface brightness. The optical and radio parameters, absolute luminosity, intrinsic color, mean intrinsic surface brightness, neutral hydrogen mass, and total mass, for the six galaxies are compared with the corresponding parameters for 54 other galaxies. The data for these galaxies indicate that the total mass to luminosity ratio is not correlated with galaxy type for galaxies later than Sab. The mean total mass to luminosity ratio for all the galaxies is about 13.5. The mean relation between the neutral hydrogen mass and the total mass for late type spiral and Magellanic irregular galaxies is $\underline{M}_{HI} \propto \underline{M}_T^{0.70}$. The luminosity distributions in the outer regions ($r^* > r_e^*$) for the six galaxies obey an exponential law of the form $\log \beta = K(\rho^* - 1)$ where $\beta = \mu/\mu_e$ and $\rho^* = r^*/r_e^*$. The luminosity distributions in NGC 6946 and IC 342 for $r^* > 0.85r_e^*$ agree well with the exponential luminosity law, $\log \beta = -0.73(\rho^* - 1)$, derived by de Vaucouleurs for late type spiral and Magellanic irregular galaxies. (Diss. Abstr.)

41880 UNRESOLVED BACKGROUND RADIATION AT 2695 MHz. Gruber, G. M. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys., 2: 369-71(July 1969).

First results of an 11-cm survey of the region: right ascension 22h to 4h, declination 30 to 90° are used to determine the extent of the galactic wings and to give an estimate of the spectral index of a part of the region. (auth)

41881 THE STRUCTURE OF THE MILKY WAY SYSTEM. Elsaesser, Hans (Univ., Heidelberg). Bild Wiss., 6: 34-43 (Jan. 1969). (In German).

The structure of the Milky Way system is discussed in the light of new evidence for stellar genesis; methods for the dating of stars, the chemistry and physics of young stars, location of young stars in the Galaxy, location of old stars, the development of the

Galaxy, and correlations with the distribution of H in the Galaxy are outlined. The older stars near the nucleus of the Milky Way have a different motion than newer stars; conceivably these oldest stars are a relic of the early period of the Galaxy, some 15 billion years ago or before. The Galaxy may well have been nearly spherical at this time and crossed by turbulent streams; such motion and distribution would be reflected in the distribution and motion of the old stars. The more recent stars' motion and position produce the disc shape of the Galaxy as it exists now. (BBB)

41882 INFRARED SPECTRUM, DIAMETER, AND POLARIZATION OF THE GALACTIC NUCLEUS. Low, F. J. (Rice Univ., Houston, Tex. Univ. of Arizona, Tucson); Kleinmann, D. E.; Forbes, F. F.; Aumann, H. H. Astrophys. J., 157: L97-101 (Aug. 1969).

Observations of the galactic center were made over the wavelength range 5 to 1500 μ. They included polarization measurements at 10 μ, diameter measurements at 10 and 22 μ, an upper limit to the flux at 1200 μ, a preliminary flux at 100 μ, and accurate flux measurements with a 25″-diameter beam at 5, 10, 11.5, 13, 18.9, 22, and 24.5 μ. Most of the energy radiated between 5 and 25 μ is produced by a source ~15″ in diameter, with linear polarization less than 2% and a spectral energy distribution similar to those found for other galaxies measured at these wavelengths. However, the power output from this 1-pc-diameter source was found to lie between 1.6×10^6 and 8×10^6 $L_\odot$, or from 2 to 10 times the power radiated by the stars in the same volume. The preliminary flux measurement at 100 μ strongly favors a nonthermal source. A reasonable fit to a 270°K blackbody distribution with an emissivity of about 0.001 is nevertheless possible if the 100-μ observation is excluded. (auth)

41883 INTERSTELLAR POLARIZATION OF STARLIGHT AND THE TURBULENT STRUCTURE OF THE GALAXY. Jokipii, J. R.; Lerche, I.; Schommer, R. A. (Univ. of Chicago). Astrophys. J., 157: L119-24(Aug. 1969).

Fluctuations in the polarization of starlight provide strong support for the concept of a turbulent interstellar medium. The mean polarization and the variance of polarization about the mean were analyzed as functions of distance R from the solar system. The mean increases linearly with R. For R less than the correlation length L the variance increases as R^2, whereas for $R \gg L$ the variance increases linearly with R. The observed mean polarization and the observed variance of polarization are found to be in excellent agreement with these theoretical deductions if the interstellar medium fluctuates irregularly with a correlation length of 150 pc. In view of these results, it is clear that some caution must be exercised in interpretation of observations of individual pulsar signal dispersion and Faraday rotation. (auth)

41884 NUCLEAR CHRONOLOGIES FOR THE GALAXY. Wasserburg, G. J.; Schramm, David N.; Huneke, J. C. (California Inst. of Tech., Pasadena). Astrophys. J., 157: L91-6(Aug. 1969).

The ratios $^{235}U/^{238}U$, $^{232}Th/^{238}U$, $^{244}Pu/^{238}U$, and $^{129}I/^{127}I$ were used to obtain self-consistent solutions for the time evolution of r-process nuclei. Using $^{244}Pu/^{238}U = 1/30$, the solutions all have a large amount of initial production, with a duration of from 0 to 10^{10} years, followed by a relatively quiescent period (~3×10^9 years) terminated by a nucleosynthetic event that possibly initiated the separation of the solar system. For values of ^{244}Pu less than $1/60$, models of uniform synthesis terminated by a sharp nucleosynthetic event are possible. (auth)

Cosmology

41885 RED SHIFTS OF VERY YOUNG OBJECTS. Arp, H. (California Inst. of Tech., Pasadena). Nature (London), 223: 386(July 26, 1969).

Attention is called to one of the consequences of the belief that there is a redshift–distance relationship for galaxies. If sufficiently faint galaxies could be observed they would be seen very close to their moment of creation, or even close to the moment of creation of the matter which would make up the galaxies, and if distant-enough matter could be seen, it would be very young and have an extremely high redshift. This leads to the finding that if the Universe near zero age could be observed it would have a very large redshift. The case where matter is created locally is considered, and the following theorem is alleged to be proved—"In the limit, observing the redshift of matter at a great distance created at the same epoch as ours is equivalent to observing the redshift of nearby matter created at a very recent epoch." This is further discussed in the light of the curved space of general relativity, which predicts that as increasingly distant galaxies are observed their diameters will reach a point where they appear to enlarge again until, if extremely distant galaxies could be observed, their diameters would begin to merge; and proceeding further, in the limit it would be expected that the age zero of the Universe would be seen in every direction. Since a logical definition of the Universe would include all matter, past and present, it must be postulated that new matter does not come into the Universe from elsewhere; it must have existed, perhaps as a diffuse or virtual potential, and then have started to localize at the time called "creation." If objects are eventually to be detected by normal observational methods the localization process must initially consist of decreasing the apparent diameter and lowering the redshift, both effects enhancing visibility. Some kind of continuous disengagement from the age zero Universe towards the state of its ultimate character would be expected. The nuclei of galaxies may be a possible materialization point, the more compact nuclei being the most favorable. If a recently created object were ever directly observed it would have a very high redshift regardless of distance. (UK)

41886 THE DETECTABILITY OF QUASARS BEYOND $Z \simeq 2$. Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett., 4: 61-4(Aug. 1969).

The apparent deficiency of quasars with redshifts substantially larger than 2 could be due to absorption by intervening atomic hydrogen, provided that the intergalactic gas was less highly ionized at early epochs than when $Z \simeq 2$. Some implications of this suggestion are discussed. (auth)

41887 DISTRIBUTION OF REDSHIFTS OF QUASARS. Tinsley, Beatrice M.; Patterson, T. N. L.; Tinsley, Brian A. (Southwest Center for Advanced Studies, Dallas. Southern Methodist Univ., Dallas). Astrophys. Lett., 4: 55-6(Aug. 1969).

The observed complex distribution of quasar redshifts has been interpreted by Barbieri, Bonometto, and Saggion (1968) as due to the combination of simple distributions of cosmological and gravitational redshifts. An error in their analysis is noted which invalidates their conclusions. (auth)

41888 COSMOLOGICAL IMPLICATIONS OF THE POSSIBLE NON-EXISTENCE OF A SECOND-ORDER CLUSTERING OF THE GALAXIES. Gerasim, A. (Brukenthal Museum, Sibiu, Roumania). Astrophys. Lett., 4: 51-4(Aug. 1969).

It is argued that if the nonexistence of a second-order clustering of the galaxies, asserted by Zwicky, were interpreted as being due to a gravitational cutoff, there could not be such intense gravitational fields as are usually claimed by the relativistic cosmologies. The Universe would be a quasi-Galilean–Euclidean one. The available observational data seem to suggest that in such a Universe the light would be redshifted by an exponential decay process of the energy of the photon. Some consequences and possible objections are discussed. (auth)

41889 STABILITY OF THE QUASISTATIC SOLUTIONS FOR A SYSTEM OF GRAVITATIONAL INTERACTING MASSES IN GENERAL RELATIVITY THEORY. Podurets, M. A. Sov. Astron. AJ (Engl. Transl.), 13: 94-100(July-Aug. 1969).

Translated from Astron. Zh., 46: 126-35(Jan.-Feb. 1969).

The local stability of nonrotating spherically symmetric systems of mass points moving in a self-consistent Einstein gravitational field was studied. For perturbations of the distribution function spherically symmetric in configuration space, with collisions absent, the stability of a considerable number of quasistatic solutions obtained previously is demonstrated. The applicability of the model to the quasar problem is discussed. (auth)

41890 THERMAL CONDITIONS IN THE INTERGALACTIC GAS. Doroshkevich, A. G.; Syunyaev, R. A. Sov. Astron. AJ (Engl. Transl.), 13: 15-20(July-Aug. 1969).

Translated from Astron. Zh., 46: 20-7(Jan.-Feb. 1969).

The possible thermal balance of the gas comprising the intergalactic medium is discussed. Energy losses by the plasma through helium radiation and the inverse Compton effect on the primordial radio emission are considered. It is shown that rapid cooling of the intergalactic gas will lead to the establishment of a nonstationary degree of helium and hydrogen ionization, and thereby to a sharp drop in the radiational losses. Possible curves are derived for the cooling of the intergalactic gas with various initial values of the density and temperature, both without allowance for heating and under various assumptions regarding the heating. The interpretations of the available experimental data on the absorption of Ly-α and the 21-cm line by intergalactic hydrogen are found to be incompatible. (auth)

41891 TIME-SYMMETRIC ELECTRODYNAMICS IN FRIEDMANN UNIVERSES. Roe, P. E. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc., 144: 219-30(1969).

Time-symmetric electrodynamics were discussed in the background of conformally flat cosmological models, in particular the Robertson–Walker models with $k = \pm 1$. It is shown that the Friedmann models with $k = -1$ behave in the same way as the Einstein–de Sitter model in giving self-consistent advanced solutions of Maxwell's equations. The universes with $k = +1$ give both the advanced and retarded solutions as self-consistent. It thus appears that a direct connection between the cosmological and electrodynamic arrows of time cannot be established in any Friedmann model. Continuous creation appears to be both necessary and sufficient to establish such a connection. (auth) (UK)

41892 A STATIONARY MODEL OF THE METAGALAXY. Laurent, B. E.; Malm, B. E. (Univ. of Stockholm). Ark. Fys., 38: 325-40(1968).

A study of the metagalactic system in the framework of general relativity is presented. The imaginary situation investigated was that radiation pressure just balances gravitation. To make computations easier, a simplified energy–momentum tensor for radiation was used. Under these conditions, it is difficult to explain a matter content considerably exceeding 10^{53}/g, which is somewhat small compared to observations. (Sweden)

41893 FOUNDATIONS OF GENERAL RELATIVITY THEORY AND THE COSMOLOGICAL PROBLEM. Klein, O. Ark. Fys., 39: 157-70(1969).

It is shown in some detail how Einstein's cosmological attempt was based on considerations strangely deviating from essential foundation of general relativity theory — the principle of equivalence — by means of which the mathematical formalism of the theory obtains its physical interpretation. It is concluded that there are hardly any a priori arguments in favor of relativistic cosmology by means of a comparison between the cosmological solutions with the ordinary solutions of general relativity corresponding to a finite system embedded in an approximately empty region. (Sweden)

41894 THE INTERACTION OF MATTER AND RADIATION IN A HOT-MODEL UNIVERSE. Zeldovich, Ya. B.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Astrophys. Space Sci., 4: 301-16(July 1969).

The investigation initiated by Weymann as to the reason why the spectrum of the residual radiation deviates from a Planck curve is continued. The distortions of the spectrum resulting from radiation during the recombination of a primeval plasma are considered. Analytical expressions are obtained for the deviation from an equilibrium spectrum due to Compton scattering by hot electrons. On the basis of the observational data it is concluded that a period of neutral hydrogen in the evolution of the Universe is unavoidable. It is shown that any injection of energy at $t > 10^{10}$ sec (redshift $z < 10^5$) leads to deviation from an equilibrium spectrum. (auth)

41895 SHORT-WAVELENGTH APPROXIMATION IN GENERAL RELATIVISTIC, KINETIC, PERTURBATION THEORY. Lyle, Robert Louis. Austin, Tex., Univ. of Texas, 1968. 88p. Thesis.

The short-wavelength approximation in general relativistic, kinetic, perturbation theory is investigated. A Robertson–Walker universe with zero spatial curvature is perturbed to first order in the context of self-consistent kinetic theory. After the general structure of the equations is elucidated, the solutions are assumed to change rapidly compared to the cosmological background and are treated by the method of Jeans as well as by a second, asymptotic perturbation. It is shown that the wave-particle interaction is a higher order effect than that of the cosmological expansion, but that the classical Jeans method omits the latter while including the former. (Diss. Abstr.)

41896 REMARKS ON QUARK STARS. Ivanenko, D.; Kurdgelaidze, D. F. (Moscow Univ.). Nuovo Cim., Lett., 2: 13-16 (July 1, 1969).

Previously the authors (1965) drew attention to the necessity of admitting the existence of a quarkian core in the interior of hypothetical superstars of very great masses. Similar considerations have been proposed by Pacini and developed by De Sabbata et al., (1966) and by Burbidge. In this note some properties of a hypothetical quarkian substance is investigated. (W.D.M.)

41897 HELIUM PROBLEM IN COSMOLOGY. Greenstein, George Samuel. New Haven, Yale Univ., 1968. 142p. Thesis.

Processes leading to the synthesis of ^{4}He during the early stages of the expansion of a universe away from a "big bang" were investigated. Results depend on the chemical potentials of the neutrinos μ_ν, on the number η of neutrino types in excess of those already discovered, and on the present averaged-out density of matter in the Universe. With μ_ν and η small (≈ 0) ^{4}He abundances by mass of 25 to 30% are produced, in excellent agreement with observed values. If μ_ν or η differ appreciably from zero either too much or too little ^{4}He is produced. Nuclear reactions subsequently taking place in stars would not alter the ^{4}He abundance appreciably. Therefore the ^{4}He abundance obtained from a cosmological theory is regarded as a test of that theory. Thus the steady-state cosmology, and general relativistic cosmologies with large values of μ_ν and/or η are rejected. In this way one is also able to place limits on parameters appearing in the Brans–Dicke scalar-tensor theory. If ^{4}He is in fact of primordial origin, the helium abundances of all stars should be essentially the same. But certain stars have been found in the galactic halo with very small ^{4}He abundances. It is shown, however, that heavy elements in these stars would diffuse below their photospheres: therefore spectroscopic observations of element abundances in their atmospheres tell nothing about their actual compositions. Therefore, there is at present no observational evidence against the conclusion that ^{4}He is of primordial origin, and that the Universe originated in, or passed through, a "big bang." (Diss. Abstr.)

41898 STABILITY OF A HOMOGENEOUS ANISOTROPIC RELATIVISTIC COSMOLOGICAL MODEL. Astorga, Jorge Krause. Austin, Tex., Univ. of Texas, 1968. 104p. Thesis.

The stability of the Kantowski–Sachs closed model against small perturbations of the metric tensor is investigated. Matter is represented by an irrotational dust source; no electromagnetic field is considered. An introduction to the problem is given in Chapter 1. As a preamble, Chapter 2 contains a brief review of the background model; the relevant formulae are given in Appendix 1, and the integration of the unperturbed Einstein field equations is considered in detail in Appendix 2. Chapter 3 is a study of the comoving coordinate system used, and contains an analysis of the consequences, for the perturbed model, due to a change of gauge. The changes induced in the perturbation tensor by allowable infinitesimal transformations of coordinates are examined and, after presenting some hydrodynamic considerations on the behavior of an irrotational dust source, the remaining gauge freedom is stated. Appendix 3 is a review on gauge transformations and the Lie derivative of a tensor field. In Chapter 4 the perturbed Einstein field equations are constructed to the first order of approximation, assuming an irrotational dust source. The perturbation contributions to the metric and to the dust density are represented in their normal modes: the radial dependence is Fourier transformed, and the angular dependence is handled by means of tensor spherical harmonics. Using these harmonic representations, the system of linearized perturbed equations decouples into an "even" modes system and an "odd" modes system. The resulting equations are checked against gauge invariance. Appendix 4 is a list of the relevant formulae for the perturbed model, and Appendix 5 contains a review of the tensorial spherical harmonics. In Chapter 5 a stability analysis of the Kantowski–Sachs closed model is considered. The "odd" parity equations corresponding to the lowest mode, $l = 1$, are integrated exactly. It turns out that this is quite a stable mode in the sense that it is permanently driven by the unperturbed background. Next, the "odd" parity equations, for any value of the angular momentum $l \geq 2$ are integrated in the slow background approximation, assuming exponential solutions. A dispersion relation is obtained, which shows that these are stable oscillatory irrotational solutions representing gravitational waves propagating radially and with their amplitude modulated in time by the background. It is shown that the validity of the slow background approximation is restricted to the neighborhood $t \simeq t_0$, and then if, and only if, $b \simeq 0$. The consequences, for the perturbed model, of the contracted Bianchi identity are next examined. It turns out that the (00)-Equation can be integrated easily in the slow background approximation. The solution shows a stable oscillatory irrotational density perturbation, which does not increase with time, but which is modulated by the unperturbed density of the background. As far as the slow background approximation is valid, it can be concluded that the dust-filled Kantowski–Sachs closed model is stable against small irrotational perturbations of the metric tensor. (Diss. Abstr.)

41899 FLUCTUATIONS IN THE MICROWAVE BACKGROUND RADIATION. Longair, M. S. (Lebedev Inst. of Physics, Moscow); Sunyaev, R. A. Nature (London), 223: 719-21(Aug. 16, 1969).

Fluctuations in the microwave background radiation may be expected as a result of perturbations in the primaeval plasma from which large-scale structures such as galaxies and clusters of galaxies were formed. So far only upper limits to the observed values of such fluctuations have been assigned, of roughly $\Delta T/T \lesssim 10^{-3}$, on the scales greater than about 3′. The background radiation at cm and mm wavelengths also contains contributions from unresolved discrete sources and diffuse matter. In the present paper a comparison is made between the magnitudes of the temperature fluctuations $\Delta T/T$ expected as a result of "primaeval" perturbations and several other possible sources of fluctuations, particularly discrete radio sources. The latter are likely to be much more important than "primaeval" fluctuations on scales less than ~3′ at all wavelengths. A lower limit to $\Delta T/T$ at 4 cm is derived, including the effect of normal galaxies. It is concluded that, for masses $>10^{15}\ M_{\odot}$, fluctuations may be observable on a scale greater than ~10′, providing important information about the spectrum of the initial fluctuations from which large-scale associations have been formed. (UK)

41900 DISTORTIONS OF THE BACKGROUND RADIATION SPECTRUM. Sunyaev, R. A.; Zeldovich, Ya. B. (Inst. of Applied Mechanics, Moscow). Nature (London), 223: 721-2(Aug. 16, 1969).

Some aspects of the cosmic blackbody radiation in relation to the "big-bang" model of the universe are discussed, with particular reference to the position if departures from the equilibrium spectrum were discovered. In this connection it is concluded that this need not lead to abandonment of the hot "big-bang" theory. There are natural processes which can lead to pronounced distortions of the spectrum, both in the low frequency and in the high frequency regions. In the real universe there are processes in which large quantities of energy are released; part of this energy is observed as radiation from discrete sources and can be distinguished from the blackbody radiation, but another part of this energy, particularly in early stages of the evolution of the universe, is transformed into cosmic radiation and distorts the equilibrium spectrum. The findings of Shivanandan et al., (Phys. Rev. Letters 21: 1460(1968)) suggested a large departure from the equilibrium spectrum, but it is stated that there is doubt about the validity of their results, and it is believed that significant departures from the equilibrium spectrum have still to be detected. Two distinct cases are discussed. (UK)

41901 GALACTIC NUCLEI AS COLLAPSED OLD QUASARS. Lyndel-Bell, D. (Royal Greenwich Observatory, Herstmonceux Castle, Eng.). Nature (London), 223: 690-4(Aug. 16, 1969).

Evidence is discussed that powerful emissions from the centres of nearby galaxies may represent dead quasars. (auth) (UK)

41902 DISCRETE SOURCES AND THE MICROWAVE BACKGROUND IN STEADY-STATE COSMOLOGIES. Hazard, C.; Salpeter, E. E. (Inst. of Theoretical Astronomy, Cambridge, Eng. Cornell Univ., Ithaca, N. Y.). Astrophys. J., 157: L87-90 (Aug. 1969).

Attempts at interpreting the observed microwave background in terms of a suitable population of extragalactic radio sources are discussed for the steady-state cosmological model. For randomly distributed point sources the requirement on the number density n of sources would be $n > 3 \times 10^{4}\ \mathrm{Mpc}^{-3}$. Even for extended sources and cosmologies with irregularities, the lower limit on n exceeds the number density of ordinary galaxies. (auth)

Planetary Phenomena

41903 VISIBILITY OF JUPITER'S RED SPOT. Argyle, E. (Univ. of British Columbia, Vancouver). Nature (London), 223: 485(Aug. 2, 1969).

The validity of the claimed existence of a relationship between the visibility (V) of Jupiter's red spot and the Zurich relative sunspot number (R_z) is discussed (Graf et al. Nature, 218: 857(1968)). Other workers found low correlation coefficients. Basu (Nature, 222: 69(1969)) attempted to substantiate the claim by smoothing and partitioning the data before performing the correlation analysis and states that, whereas the smoothed visibility function during 1894 to 1945 was dependent on solar activity, this dependence vanished or changed about 1947 and had not returned by 1965. The present author points out that the visibility of the red spot changes in an erratic manner, and no convincing physical theory has been offered to account for these variations. Furthermore, available data do not specify the nature of any relationship, and no amount of re-examination of inadequate data is likely to provide cogent evidence for what is not apparent at first sight. (UK)

41904 Hα AURORAL ACTIVITY ON JUPITER. Hunter, J. H. (Naval Research Lab., Washington, D. C. Yale Univ., New Haven). Nature (London), 223: 388-9(July 26, 1969).

Several investigators have unsuccessfully searched for Hα emission from Jupiter. The purpose of the present communication is to report new results that may be interpreted as Hα auroral activity on the planet. The observational data were obtained at the Waldorf site, Maryland, on the night of March 4– 5, 1969, employing a 16-inch telescope equipped with an image orthicon camera with an S-20 photocathode. The Hα feature was isolated by placing in the optical path various combinations of Fabry–Perot etalons, centered on Hα. Features were observed on the associated television screen which appeared to wander about on the Jovian limb at a timescale of minutes. If these features constituted an Hα aurora, its surface brightness was of the order of a few kilorayleighs. The results do not provide unambiguous proof of the existence of a Jovian aurora, and might have been due to instrumental effects. Further study, however, has indicated that some Hα activity may be present. (UK)

41905 JUPITER, THE RADIOACTIVE PLANET. Smith, Alex G. Amer. Sci., 57: 177-92(Summer, 1969).

The discovery of an explanation for radio emission from Jupiter is reviewed. Radio astronomy has shown that Jupiter is unique among the planets of our solar system, in emitting great outbursts of short-wave radio signals. Only the Sun itself rivals Jupiter in the strength of its radio emission. The Jovian radio signals are highly intermittent. They occur in so-called "noise storms," which may last only a few minutes or for hours. Recording of a typical noise storm is illustrated. The Jupiter signals are superimposed on a steady background of cosmic radio noise representing synchrotron emission from electrons gyrating in the weak magnetic field of the Galaxy. The Jovian radio noise occurs in short, intense bursts or pulses, of two distinct classes. The most common type is relatively slow, lasting from a few tenths of a second to several seconds. The other kind of burst is extremely short, lasting only a few thousandths of a second. The bursts almost disappear above 30 Mc, but toward the lower frequencies rapidly grow stronger until a point is reached, generally between 5 and 10 Mc, where the signals can no longer penetrate the Earth's atmosphere. The periodicity of the radio emission and its relation to Jupiter's radiation belts are discussed. Theories of the radio bursts relate to the discovery that Jupiter is surrounded by belts of high-speed charged particles, much like the Earth's Van Allen belts but much larger and more intense. Theories of the short-wave radio noise storms now generally assume that they result from some disturbance that causes charged particles to be dumped out of the radiation belts into Jupiter's lower atmosphere, an idea analogous to current theories of the terrestrial aurorae. A possible source of such disturbances is the gas which erupts from explosions on the Sun and extend to the Jovian radiation belts. An inverse relation between Jovian radio emission and sunspot activity is apparent. A possible explanation is that, near sunspot maximum, interplanetary space is heavily contaminated by clouds of solar gas carrying irregular magnetic fields. These obstacles may prevent electrons and protons from the Sun from reaching Jupiter to recharge the radiation belts; they may also block the disturbances that cause dumping of the particles from the belts. (BBB)

41906 RADIO EMISSION OF VENUS AND JUPITER AT 2.25 AND 8 mm. Efanov, V. A.; Kislyakov, A. G.; Moiseev, I. G.; Naumov, A. I. (Crimean Astrophysical Observatory, Moscow. Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 13: 110-13(July-Aug. 1969).

Translated from Astron. Zh., 46: 147-51(Jan.-Feb. 1969).

Results are presented of observations of the radio emission of Venus and Jupiter at 2.25 and 8 mm made on the 22-m radio telescope of the Crimean Astrophysical Observatory during September–October, 1968. The brightness temperature of Venus determined by comparison with the intensity of radio emission from Jupiter, is $T_{♀} = 235 \pm 40°K$ at $\lambda = 2.25$ mm and $T_{♀} = 375 \pm 60°K$ at $\lambda = 8$ mm. The brightness temperatures of Venus and Jupiter at 2.25 mm, determined by the method of comparison with the Sun's temperature, is $T_{♀} = 290 \pm 90°K$ and $T_{♀} = 180 \pm 60°K$. An optical thickness of the cloud cover of Venus $\gamma \gtrsim 2.33$ has been estimated as a lower limit. (auth)

Atomic and Molecular Physics

41907 ELECTROMAGNETIC FIELD. Anderson, N. Logos Press Limited Scientific Publications. New York, Plenum Press, 1968. 135p.

Chapters on the following topics are included: (1) the field equations, (2) the electrostatic field, (3) the magnetostatic field, (4) electromagnetic waves, (5) energy and momentum of an electromagnetic field, (6) motion of charged particles in electromagnetic fields, (7) fields due to moving charged particles, and (8) the problem of charged particles in classical electromagnetic theory. (M.O.W.)

41908 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 4, NO. 6. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main, Ger., Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 132p.

A listing is presented of 253 articles on various aspects of surface and vacuum physics. Subject and author indexes are included. (M.O.W.)

41909 INCOHERENT SCATTERING OF 279-keV PHOTONS BY K ELECTRONS IN GOLD. Pingot, O. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belgium). Nucl. Phys., A133: 334-6(1969). (In French).

The differential cross section $d\sigma_k/d\Omega$ for the incoherent scattering of 279-keV gamma rays by the K-shell electrons of gold is determined experimentally. This cross section is compared with the Klein–Nishina cross section $d\sigma_1/d\Omega$ for scattering angles from 20° to 160°. For the large scattering angles, the experimental results are in good agreement with the incoherent scattering function calculated on the basis of certain approximations. (auth)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 41032 and 41176.

41910 (AD-685386) PHOTOELECTRIC CROSS SECTIONS IN THE keV RANGE. Brysk, H.; Zerby, C. D. (Union Carbide Corp., White Plains, N. Y. Materials Systems Div.). Feb. 21, 1968. Contract DA-49-146-XZ-511. 26p. (UCC/AS-314). CFSTI.

Photoelectric cross sections have been computed, using bound-state wave functions and potentials from a relativistic Dirac–Slater self-consistent-field program and numerical integration for the continuum wave functions and the matrix elements. Results for aluminum in the range 1 to 150 keV and for uranium in the range 80 to 150 keV are compared with existing experimental and theoretical data, with particular emphasis on the angular distributions. (auth)

41911 (CEA-CONF-1280) VARIATION OF THE CHARGE STATE CURVES OF HEAVY IONS AS A FUNCTION OF THE ELECTRON SHELLS. Papineau, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 3p. (In French). (CONF-690314-3). Dep.

From Conference on the Physics and Production of Heavy Ions, La Plagne, France.

By use of experimental data from the literature on the charge states of ions with $Z > 10$, an attempt was made to establish semi-empirical charge state curves of ions as a function of the electron shells of the incident ions and of the electron shells of the material crossed. The curves obtained show the continuity of the charge states of ions in reduced coordinates $V/Z^{1/2}$ according to the nature of the incident particle and of the absorber. (J.S.R.)

41912 (SC-TM-67-2900) ANALYTICAL EXPRESSIONS FOR BREMSSTRAHLUNG SPECTRA EMITTED BY HIGHLY FILTERED, THICK HIGH-Z TARGETED X-RAY DEVICES FROM 2 TO 20 MeV. Golden, J. C. Jr. (Sandia Labs., Albuquerque, N. Mex.). Dec. 1967. 29p. Dep. CFSTI.

A model is proposed for bremsstrahlung spectra in the forward direction for maximum electron kinetic energies from 2 to 20 MeV. Three basic spectra functions are described, one each for the photon flux density, the intensity, and the exposure rate. It is believed that the value of the equations will be increased in that there are only three input variables needed to describe the spectra; maximum electron kinetic energy, unit of exposure time, and total intensity or total exposure rate in the forward direction. It will be shown that the analytical functions described herein provide a method for estimating the spectra of most highly filtered, thick high-Z targeted, x-ray devices to which the model applies. (auth)

41913 (UCRL-19034) CHARACTERIZATION OF MULTICHANNEL SOURCES AND THEIR UTILIZATION IN MOLECULAR BEAM SYSTEMS. Olander, D. R.; Jones, R. H. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 16p. (CONF-690709-1). Dep. CFSTI.

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France.

Multichannel arrays have become increasingly popular sources for generating molecular beams for a variety of beam–surface and crossed-beam experiments. The properties of a molecular beam from a channel source are calculated using a model that regards intermolecular collisions in the channel as a perturbation of the distribution function for free molecule flow. The angular distribution is predicted to be less peaked than that from the same source under free molecule flow conditions. The velocity distribution is harder than a Maxwellian. Experimental data supporting these predictions are reviewed. (auth)

41914 (UCRL-50174(Sec.2)(Rev.1)) COMPILATION OF X-RAY CROSS SECTIONS. McMaster, W. H.; Del Grande, N. Kerr; Mallett, J. H.; Hubbell, J. H. (California Univ., Livermore. Lawrence Radiation Lab.). May 1969. 261p. Dep. CFSTI.

Graphs and tables of x-ray cross sections in the range of 1 keV to 1 MeV are included. The total cross sections presented are the sum of computed scattering cross sections and a combination of the fit to derived experimental and theoretical photoelectric cross sections. (auth)

41915 (USC-136-147) QUANTUM MECHANICAL COLLISION SPECTRA IN ENERGY LOSS STRAGGLING. Bichsel, Hans (University of Southern California, Los Angeles. Dept. of Physics). Jan. 1969. Contract AT(04-3)-136. 23p. Dep. CFSTI.

The quantum mechanical collision cross sections calculated with hydrogenic wave functions for the K and L shells are used to find the moments of the straggling functions. They are compared with the corresponding moments of the free-electron collision cross sections used in the Vavilov theory. For light elements, the straggling curves are broadened by up to 5% for this effect; for heavy elements somewhat larger effects are expected. For very low particle energies, a narrowing of the curves is predicted. (auth)

41916 (USC-136-148) PRECISION ENERGY LOSS MEASUREMENTS FOR NATURAL ALPHA PARTICLES IN ARGON. Bichsel, Hans; Hanke, C. C.; Buechner, J. (University of Southern California, Los Angeles. Dept. of Physics). Mar. 1969. Contract AT(04-3)-136. 44p. Dep. CFSTI.

Energy losses of natural alpha particles from ^{212}Bi and ^{212}Po were determined in argon gas with an accuracy of about 0.2%. The Lewis correction and the multiple scattering correction are briefly discussed. The data are compared with the Bethe theory, formulated with two different shell-correction functions. Values for I (mean ionization energy) of 182 and 167 eV are obtained by the two methods. Northcliffe's measurements at higher energies favor I = 182 eV. (auth)

41917 SCATTERING OF LOW-ENERGY PROTONS BY COMPOUND SINGLE CRYSTALS: A COMPUTER SIMULATION. Torrens, I. M.; Chadderton, L. T.; Anderson, M. G. (North American Rockwell Corp., Thousand Oaks, Calif.). Radiat. Eff., 1: 47-53(Jan. 1969).

A classical mechanical computer simulation of the emission of low-energy protons from a single-crystal surface of potassium chloride is described. Comparison of the results is made with experimental observations obtained in reflection and transmission at 30 keV. It is concluded that classical mechanics adequately explains the observed features down to energies as low as 5 keV, in keeping with a "correspondence principle" previously outlined. Brief discussion is made of the usefulness of the backscattering technique. (auth)

41918 COMPLEX-ENERGY METHOD FOR ELASTIC e–H SCATTERING ABOVE THE IONIZATION THRESHOLD. McDonald, F. A.; Nuttall, J. (Texas A and M Univ., College Station). Phys. Rev. Lett., 23: 361-3(Aug. 18, 1969).

It is demonstrated that the amplitude for elastic electron–hydrogen-atom scattering above the ionization threshold can be calculated by using a variational method at several complex energies and continuing into the physical region numerically. (auth)

41919 THE K-IONIZATION CROSS SECTION OF ALUMINUM BY ELECTRON IMPACT (3 TO 30 keV). Hink, W.; Ziegler, A. (Univ., Wuerzburg, Ger.). Z. Phys., 226: 222-34(1969). (In German).

The K-ionization cross section of aluminum by electron impact was measured by detecting quantitatively the Al K x rays emitted by thin targets of known mass thickness. The apparatus and the measurements are briefly described. The experimental results are considerably higher than theoretical values based on the Born approximation. The discrepancy increases with increasing energy of the incoming electron. At twenty times threshold energy, for example, the measurements are higher than Burhop's [Proc. Cambridge Phil. Soc., 36: 43(1940)] calculations by a factor of 1.7. It is shown that in the process of K ionization the influence of the nuclear field on the impact electron increases with decreasing atomic number. Thus, the calculations of Rudge and Schwartz [Proc. Phys. Soc.(London), 88: 563(1966)] using Coulomb wave functions for the impact electron are closest to the measurements (maximum deviation 16%). The formula of Gryzinski [Phys. Rev., 138: 336(1965)] based on classical calculations is a good approximation to the experimental results if multiplied by a factor 1.23. (auth)

41920 TRANSMISSION AND BACKSCATTERING OF 4.0- TO 12.0-MeV ELECTRONS. Ebert, P. J.; Lauzon, A. F.; Lent, E. M. (Univ. of California, Livermore). Phys. Rev., 183: 422-30 (July 10, 1969).

Transmission and backscattering coefficients were measured for 4.0- to 12.0-MeV monoenergetic electrons normally incident on solid targets of C, Al, Cu, Ag, Ta, and U. Transmitted and backscattered electrons were collected by biased Faraday cups, each subtending ~90% of 2π sterad. Number transmission coefficients at 10 MeV agree with Berger and Seltzer's Monte Carlo results, and saturation backscattering coefficients generally agree with Tabata's results to within ±10%. Empirical formulas for determining the extrapolated range and both the transmission and backscattering coefficients as a function of Z, energy, and thickness were developed. (auth)

41921 STOPPING POWER OF SOLIDS FOR FAST-MOVING TANTALUM IONS. Kalish, R. (Massachusetts Inst. of Tech., Cambridge); Grodzins, L.; Chmara, F.; Rose, P. H. Contract AT(30-1)-2098. Phys. Rev., 183: 431-5(July 10, 1969).

The results of measurements of energy losses, dE/dX, of 10- to 140-MeV Ta ions in C, Al, Ag, and Au foils are presented. The relative effective charges responsible for the electronic part of the slowing down process are deduced from the data, using the Bethe–Bloch formalism. These agree well with semiempirical extrapolations based on dE/dX data, using lighter projectiles. For a given energy the effective mean charges deduced from dE/dX measurements in solids are considerably smaller than the mean charges measured directly after passing the ions through such solids, but agree quite well with the mean charges measured after traversing gases. (auth)

41922 ON SPUTTERING PROBABILITY OF SECONDARY TUNGSTEN OXIDE IONS WITH Ar^+ IONS. Rybalko, V. F.; Kolot, V. Ya.; Fogel, Ya. M. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 913-19(June 1969). (In Russian).

The results of studying tungsten oxidation by the secondary ion emission method was compared with those obtained by the flash filament and the work function methods. A conclusion was drawn that the sputtering probability of secondary tungsten oxide ions does not depend on tungsten strip temperature, concentrations and composition of tungsten oxides on the tungsten surface. It is also shown that: (1) a bombardment of the tungsten surface with a primary ion beam does not influence the tungsten oxidation rate; (2) the association of adsorbed oxygen particles with the atoms of tungsten in collisions of primary ions with the tungsten surface is of no importance in the formation of the secondary tungsten oxide ions. (auth)

41923 REGULATION OF ATOMIC HYDROGEN FLOW WITH A PLATINUM WIRE DETECTOR. Brenner, Douglas (Harvard Unvi., Cambridge, Mass.). Rev. Sci. Instrum., 40: 1234-5(Sept. 1969).

A detector has been constructed for the purpose of regulating the flow of a beam of atomic hydrogen. The detector utilizes the heat produced by recombination of atomic hydrogen on a fine platinum wire to change the resistance of the wire. After a desired flux level has been set, further resistance changes of the wire are detected to provide a correction signal which is amplified and fed back to the rf oscillator which dissociates the hydrogen (other types of dissociators can also be used, with suitable modifications in the feedback system). The system can regulate hydrogen atom flow to a few tenths of a percent over several hours, where drifts without the regulator would be about 10%. Over a day the atom flow can be regulated to better than 1%. Fluctuations in the hydrogen beam are often caused by changes in the characteristics of the source discharge which are independent of molecular hydrogen pressure. Since this system is sensitive only to the true atomic hydrogen flux, it is superior to regulators which only control the pressure of molecular hydrogen in the source bulb. (auth)

41924 PRODUCTION OF A 2^3S HELIUM BEAM. Fry, E. S.; Williams, W. L. (Univ. of Michigan, Ann Arbor). Rev. Sci. Instrum., 40: 1141-3(Sept. 1969).

Beams of metastable helium produced by electron bombardment generally contain atoms in both the 2^1S and 2^3S states. It is important in many experiments to distinguish between these states, or at least to know the population ratio. A beam of 2^3S and ground state helium atoms has been produced by electron bombardment and subsequent resonant quenching of 2^1S atoms with 2^1S-2^1P 2 μ radiation. This radiation mixes the 2^1S and 2^1P states, the latter decaying primarily to the 1^1S state by emission of 584 Å radiation. The quenching has been studied as a function of beam atom velocity. The results indicate that beams of metastable helium containing less than 1% 2^1S atoms can be produced. (auth)

41925 EXPERIMENTAL DETERMINATION OF THE CROSS SECTION FOR EXCITATION OF CHARACTERISTIC X RADIATION BY α-PARTICLE BOMBARDMENT. PART II. Komarek, P. (Technisch Hochschule, Vienna). Acta Phys. Austr., 27: 369-75 (1968). (In German).

The effective cross sections for the excitation of the characteristic x radiation in the wave length from 0.7 to 10 Å under α-particle bombardment were determined. The particle energy could be selected up to a maximum value of 5.3 MeV. The measurement apparatus corresponds essentially to that described in Part I. The K x-radiation excitation of the elements from Al to Mo and the L x-radiation excitation of the elements from Se to Bi were measured. The effective cross sections show a strong dependence on the atomic number and are, for the K series, in the area of 2 b in Mo up to 830 b in Al. For the L series they are in the range of 20 b in Bi up to 5000 b in Se at 5.3-MeV α energy. A comparison of the measurements with the results of quantum theoretical calculations is satisfactory. (tr-auth)

41926 PROCESS FOR PRODUCING NEGATIVE HYDROGEN IONS. (to Lake Forest Coll.). British Patent 1,147,931. Apr. 10, 1969. Priority date May 3, 1965, United States.

A relatively intense beam of low-energy negative hydrogen atoms may be produced by passing a beam of protons of energy up to about 2 keV through a gas of alkali metal atoms to produce a beam of metastable hydrogen atoms and passing the beam of neutral atoms through a gas having an ionization energy of at least 11.0 eV in order to selectively ionize metastable hydrogen atoms in preference to ground-state atoms. Polarized ions may be produced by passing the beam of metastable hydrogen atoms through a sufficiently strong magnetic field. (A.G.W.)

Atomic and Molecular Properties

Refer also to abstracts 41847, 41853, 42237, and 42600.

41927 (AEC-tr-7083) MULTIPHOTON IONIZATION OF A SODIUM ATOM. Delone, G. A.; Delone, N. B.; Donskaya, N. P.; Petrosyan, K. B. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17745. 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 12521.

41928 (ANL-Trans-767) APPLICATION OF THE TECHNIQUES OF THE PERTURBATION THEORY OF CALCULATING THE IONIZATION ENERGY OF THE LITHIUM ATOM. Matulis, A. Yu.; Bandzaitis, A. A. Translated for Argonne National Lab., Ill., from Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad. Liet. TSR Aukst. Mokyklos, 6: 497-505(1966). 14p. Dep. CFSTI.

The results of the calculation of contributions from the Feynman diagrams of the first two orders of the perturbation expansion to the ionization energy of the ns and np electrons (n = 2, 3, 4) of the lithium atom are presented. A secondary quantization system of one-electron functions defined by a constant analytical potential is used. The results are compared with corresponding results of calculations using the self-consistent-field technique, and with the experimental data. The calculations were performed on the BESM-2M electronic computer. (auth)

41929 (ITF-69-32) SYSTEMS OF PARTICLES WITH COULOMB INTERACTION. [PART] I. Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). [1969]. 8p. (In Russian). Dep.

A previously developed [1,2] technique for dealing with one-particle oscillator functions is used for the variational calculation of the ground-state energy of a particle system with Coulomb interaction. Polyelectronic atoms and the quasi-neutral electron–proton systems are considered. (auth)

41930 (LA-4120) APPARENT OSCILLATOR STRENGTH DEPRESSION IN CESIUM–NOBLE GAS MIXTURES AT LOW PRESSURES. Sollid, J. E. (Los Alamos Scientific Lab., N. Mex.). Feb. 1969. Contract W-7405-eng-36. 12p. Dep. CFSTI.

The effects of noble gas perturbers on alkali absorption line spectra are reviewed. Particular attention is given to the depression of derived or apparent oscillator strengths for the cesium–noble gas systems. This effect may be due to molecule formation of perturber and absorber atoms and/or to invalidity of analytical methods in the low-pressure regime. The problem is discussed and illustrated with recent data obtained for the low-pressure regime. Values for the optical collision diameter in the cesium–argon and cesium–krypton systems are reported. The former agrees with a previously reported value; the latter has not been reported. (auth)

41931 A MEASUREMENT OF THE $2^2S_{1/2}$ TO $2^2P_{3/2}$ ENERGY SEPARATION IN ATOMIC HYDROGEN. Kaufman, Stanley Lee. New Haven, Yale Univ., 1968. 83p.

Thesis.

A precision measurement of the fine-structure interval ($\Delta E - \mathscr{S}$) in atomic hydrogen is reported. The transition $2^2S_{1/2}(m_j = 1/2) - 2^2P_{3/2}(m_j = 3/2)$ was used in the measurement. Hydrogen atoms in the 2S state are produced directly by bombarding molecular hydrogen with electrons. An rf electric field induces mixing with the 2P states, and the signal results from detection of the ensuing 1216-Å radiation. The 2S atoms remain in or near the electron beam in which they are produced. The effects of this environment on the results are estimated, and experimental searches are made for such effects. A method of normalization is described, which removes many sources of asymmetry. Small shifts in the results with gas pressure and electron-beam current are detected, which may be related to an asymmetry shown to exist for unnormalized data. The results of the normalized data are extrapolated to zero pressure and beam current, and $(\Delta E - \mathscr{S})_H$ is found to be 9911.36 ± 0.10 MHz, slightly in disagreement with the value expected on the basis of previous precision measurements in deuterium. The effect of this discrepancy on the value of the fine-structure constant is discussed provisionally. It is felt that measurements on the other transitions are required to confirm the discrepancy. (Diss. Abstr.)

41932 ALPHA-PARTICLE-INDUCED LUMINESCENCE IN ARGON IN AN ELECTRIC FIELD. Bennett, J. R.; Collinson, A. J. L. (Borough Polytechnic, London). J. Phys., B (London), 2: 571-7(May 1969).

The fluorescence emission from purified argon at atmospheric pressure was analyzed spectrophotometrically by the use of calibrated optical filters. Over 90% of the total emission was found to be contained within the continuum centered at 1250 Å. By examining the effect of an applied electric field on the continuum centered at 2250 Å, the origin of this emission is suggested as being above the lower energy limit for dimeric ion formation at 14.7 ev. No evidence was found for the presence of columnar dissociative recombination along the alpha-particle track. (auth)

41933 ROTATIONAL ANALYSIS FOR A PERTURBED $^1\Pi$ STATE IN ThO. Edvinsson, Gunnar; Bornstedt, Anita V.; Nylen, Per. (Univ. of Stockholm). Ark. Fys., 38: 193-218(1968).

A new $^1\Pi$ state assigned I $^1\Pi$ has been found for the ThO molecule. Rotational analysis shows that this I $^1\Pi$ state is perturbed by higher vibrational levels of the previously analyzed $G^1\Delta$ state. The analysis of the perturbation, performed with computer, makes it possible to relate the $G^1\Delta$ and $H^1\Phi$ states, previously analyzed, to the state $X^1\Sigma$. Some derived molecular constants are given. (auth) (Sweden)

41934 ISOTOPE SHIFT BETWEEN ^{209}Bi AND 6.3-DAY ^{206}Bi. Magnante, P. C.; Stroke, H. H. (New York Univ., N. Y.). J. Opt. Soc. Amer., 59: 836-41(July 1969).

The hyperfine structures of ^{206}Bi (6.3 day) and ^{209}Bi (10^{18} year) were measured with the use of a 10-m focal-length Czerny–Turner grating monochromator, and the isotope shift between them was obtained. The radioactive isotope ^{206}Bi was produced by proton bombardment of ^{206}Pb. A radiochemical procedure was developed for separating the radioactive bismuth from the lead target and transferring it into an electrodeless lamp. The light source contained about 10 ng of ^{206}Bi. From an analysis of the hfs in the $6p^3\ ^4S_{3/2}$ and $6p^27s\ ^4P_{1/2}$ states, a value of 121 ± 13 mK was obtained for the ^{206}Bi–^{209}Bi isotope shift in the 3067-Å resonance line. The possible effect on this value of perturbations by other isotopes is discussed. (auth)

41935 FRANCK–CONDON FACTORS FOR BAND SYSTEMS OF MOLECULAR HYDROGEN. III. THE ($B'^1\Sigma_u^+ - X^1\Sigma_g^+$), ($E^1\Sigma_g^+ - B^1\Sigma_u^+$), ($G^1\Sigma_g^+ - B^1\Sigma_u^+$), AND ($k^3\Pi_u - a^3\Sigma_g^+$) SYSTEMS. Spindler, R. J. Jr. (Raytheon Co., Sudbury, Mass.). Contract NAS 3-7990. J. Quant. Spectrosc. Radiative Transfer, 9: 1041-65(Aug. 1969).

Franck–Condon factors are reported for the above band systems of molecular hydrogen. In each electronic state wave functions were computed for all vibrational levels up to the dissociation limit by numerical solutions of the radial Schrödinger equation using a tabulated potential-energy function. In the X, B, and B′ states Rydberg–Klein–Rees (RKR) potential curves were used; in the E, G, a, and k states Morse potentials were used. The RKR curves were constructed for energies corresponding to integral and nonintegral vibrational quanta, using spectroscopic data selected from the literature. These curves were extrapolated to prescribed dissociation limits by means of suitable power law potential formulae. The resulting sets of Franck–Condon factors are given for all vibrational bands of each system. (auth) (UK)

41936 RELATIVISTIC TREATMENT OF THE SHIELDING OF THE ELECTRON AND PROTON MAGNETIC DIPOLE MOMENTS IN ATOMIC HYDROGEN. Hegstrom, Roger A. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 184: 17-22(Aug. 5, 1969).

The Breit equation for two Dirac particles in an external magnetic field, with anomalous magnetic moments introduced phenomenologically as Pauli moments, is taken as the starting point for a Chraplyvy–Barker–Glover reduction. First-order perturbation theory employing the nonrelativistic wave function for the ^2S ground state is then used to derive expressions for the diagonal matrix elements of the Hamiltonian that depend linearly upon the field. These expressions are symmetric in the masses and anomalous moments of the particles and agree with previous results to relative order α^2. However, additional higher-order terms arise from changes in the anomalous moments (in principle, obtainable from field theory), from reduced mass corrections, and from factorization of the moments as free-particle moments times shielding corrections. Contributions to the shielding expressions are interpreted as arising from (1) relativistic mass corrections, (2) spin–orbit coupling, and (3) spin–other–orbit coupling. In the case of atomic hydrogen the first two effects dominate the electron shielding and the latter dominates the proton shielding. Similar calculations and interpretations may be applied to magnetic shielding in larger atomic and molecular systems. (auth)

41937 GENERALIZED OSCILLATOR STRENGTHS OF THE HELIUM ATOM. III. TRANSITIONS FROM THE GROUND STATE TO THE 3^1D AND 4^1P STATES. Kim, Yong-ki; Inokuti, Mitio (Argonne National Lab., Ill.). Phys. Rev., 184: 38-43(Aug. 5, 1969).

The generalized oscillator strengths of He for the $1^1S \rightarrow 3^1D$ and 4^1P transitions have been calculated with correlated wave functions, according to both the length and velocity formulas. The agreement between the two alternative results is within 3% or less for moderate values of the momentum transfer. The resulting Born cross sections for charged-particle impact are also given. Compared with our values, available experimental data on the 3^1D excitation are substantially larger, while for the 4^1P excitation they agree within ±50%. (auth)

41938 PERIODIC INTENSITY FLUCTUATIONS OF BALMER LINES FROM SINGLE-FOIL EXCITED FAST HYDROGEN ATOMS. Sellin, I. A.; Moak, C. D.; Griffin, P. M.; Biggerstaff, J. A. (Oak Ridge National Lab., Tenn.). Phys. Rev., 184: 56-63(Aug. 5, 1969).

Protons with velocities ranging from 3.2×10^8 to 6.3×10^8 cm/sec were passed through a carbon foil producing excited hydrogen atoms, which decayed in flight after emergence. With the foil in magnetic fields from 2 to 25 G, the lines H_α through H_ϵ showed periodic intensity fluctuations due to Stark mixings of fine-structure levels caused by motional electric fields (6 to 158 V/cm). An extension of the Bethe–Lamb theory of Stark quenching provides good agreement between a small number of theoretically dominant frequencies and the measured fluctuation frequencies. Apparent discrepancies between theory and experiment noted by other experimenters are shown to be removed by our calculations except in one measurement on Ly_α. The necessity of using double foils postulated in the previous work is discussed. Our analysis suggests the preferential alignment of the final-state angular momenta perpendicular to the beam direction. Reasons for this alignment are given. (auth)

41939 REDUCED GREEN'S FUNCTION FOR THE GROUND STATE OF THE HYDROGEN ATOM. White, Ronald J. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 184: 245-6 (Aug. 5, 1969).

The reduced Coulomb Green's function for the ground state of the one-electron atom is obtained in closed form by direct solution of the relevant differential equation. (auth)

41940 USE OF GREEN FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. VI. THE FIRST-ORDER PERTURBATION TO THE EIGENFUNCTION OF THE HELIUM-ATOM GROUND STATE. Hameka, H. F. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys., 51: 1148-55(Aug. 1, 1969).

An analytical expression for the first-order perturbation correction to the eigenfunction of the He-atom ground state is presented. The expression is derived from the previously obtained He-atom Green function and it has the form of a series expansion in terms of Legendre polynomials $P_n(\cos\theta_{12})$ where θ_{12} is the angle between the position vectors of the two electrons. The coefficients of the expansion, which are functions of the electron coordinates (r_1,r_2), are obtained in the form of integral representations. (auth)

41941 ACCURACY OF NUMERICAL HARTREE–FOCK WAVE FUNCTIONS FOR HEAVY ATOMS. Kelly, Paul S. (Lockheed Palo Alto Research Lab., Calif.); Platas, Oscar R.; Bagus, Paul S. J. Chem. Phys., 51: 1261-2(Aug. 1, 1969).

In order to test the hypothesis that Hartree–Fock wave functions without relativistic corrections may be useful for calculations involving outer electrons in heavy atoms, neutral and ionized wave functions were computed for a series of noble gas atoms (Ne to Rn) for which experimental data are available. Ionization potentials were then determined directly by subtracting the computed total energies. Calculations were also made for Ra and U. When calculated values are compared with experimental data, the difference shows a fairly smooth decrease with increasing atomic number, except for Ra. It is concluded that Hartree–Fock calculations without relativistic corrections can give useful information about ionization potentials for any atom. (A.G.W.)

41942 ATOMIC HYDROGEN MASER. Ramsey, Norman F. (Harvard Univ., Cambridge, Mass.). Amer. Sci., 56: 420-38 (Winter 1968).

The atomic hydrogen maser was used to measure with increased accuracy the separation of the energy levels of atomic hydrogen and its isotopes. All results are consistent with the equation for hydrogen: $\Delta\nu(H) = 1{,}420{,}405{,}751.786 \pm 0.010$ Hz; for deuterium: $\Delta\nu(D) = 327{,}384{,}352.3 \pm 2.5$ Hz, and for tritium: $\Delta\nu(T) = 1{,}516{,}701{,}470.7938 \pm 0.0071$ Hz. The measurement on atomic hydrogen is based upon international definition of the second in terms of the hyperfine separation of atomic cesium, and the other measurements are based on the assumption that the value for hydrogen in the first equation is exactly correct. The theory of the atomic hydrogen hyperfine separation is considered from the point of view of quantum electrodynamics. It can be seen from the 1st and 3rd equations that the frequency for atomic tritium is approximately the same as for atomic hydrogen. As a result, in this measurement it was easily possible to tune a normal hydrogen maser to operate at the frequency for tritium. Consequently, the measurements could be made with high accuracy. The principal problem in the case of the tritium measurement arose from the intense radioactivity of the tritium isotope, which required more complicated gas-handling procedures. For the atomic deuterium, however, the frequency differs from that of atomic hydrogen by more than a factor of 4, in which case the wavelengths and the necessary size of the cavity do likewise. So far, it has not been possible to make a true deuterium maser of this different size. Consequently, a different technique was used. The measurement recorded above was made by a spin-exchange technique. The strength of the hydrogen maser signal provided a detector for the existence of the atomic deuterium transition, and the atomic deuterium hyperfine frequency could thereby be measured. The accuracy of the measurement is considerably less than that for hydrogen and tritium. (BBB)

41943 STRUCTURE OF THE SPECTRUM OF NEUTRAL TERBIUM, Tb I. PART V. THE CONFIGURATION $4f^85d^26s$. Klinkenberg, P. F. A.; Meinders, E. (Univ., Amsterdam). Physica, 42: 213-41(Apr. 21, 1969).

The even level system in Tb I which has been assigned to the electron configuration $4f^85d6s^2$ in preceding papers has now been extended with a ^{10}G term that marks the beginning of the configuration $4f^85d^26s$. Its lowest levels follow a distorted pattern very much similar to that of the ^8G ground term, notwithstanding the fact that the experimental g-factors are close to the Landé values. Comparison with other coupling schemes shows that the coupling in the new configuration is surprisingly near to the Russell-Saunders limit. Several of the strongest lines in the spectrum which do not show a trace of self-reversal are now classified as transitions to $^{10}G_{17/2,15/2,13/2,11/2}$ while many other odd levels do not combine at all with the new levels. This opens the possibility of discriminating between the odd configurations $4f^85d6s6p + 4f^85d^26p$ on the one hand and $4f^86s^26p$ on the other. Some new odd levels have been established thanks to their strong transitions to the new configuration. The even ^{10}G is complete except for $^{10}G_{9/2}$ which is expected around 11,000°K. The number of newly classified lines is 787 whereby the total number of classified Tb I lines is raised to 4020, being combinations between 36 even and 318 odd levels. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 42725.

41944 POSITRONIUM FORMATION IN HYDROGEN. Majumdar, Chanchal K.; Rajagopal, A. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 184: 144-51(Aug. 5, 1969).

The cross section for positronium formation by positron collisions in hydrogen was calculated from equations of three-particle scattering. The peak value obtained, $\sigma = 1.45\ \pi a_0^2$, is about 25% higher than the Born approximation value, but at high energies the value obtained here is lower. Comparison with other calculations is also reported. (auth)

41945 FINITE SLIT-LENGTH CORRECTION IN POSITRON ANNIHILATION EXPERIMENTS. Mijnarends, P. E. (Reactor Centrum Nederland, Petten, Netherlands). J. Appl. Phys., 40: 3027-33(June 1969).

The effect of the detector slit length in measurements of the angular correlation of annihilation radiation is treated theoretically. A general formula is derived, which expresses the coincidence rate from a single crystal in terms of the anisotropic momentum distribution, and its behavior is investigated in the limits of very long and very short slits. The result for the special case of an isotropic momentum distribution is compared with an earlier result of Arifov, Gol'danskii, and Sayasov. It is further concluded that line slits are to be preferred to point slits for the measurement of strongly anisotropic momentum distributions, about which no a priori information is available. (auth)

41946 VALIDITY OF APPROXIMATIONS USED IN MESONIC ATOM CALCULATIONS. Seki, Ryoichi (Univ. of Denver). Phys. Rev., 182: 1773-9(June 25, 1969).

The Deser–Goldberger–Baumann–Thirring (DGBT) formula $[a = \frac{1}{4}B(\Delta E_{1S}/|E_{1S}|)]$ and other various approximations commonly used to extract meson-nucleus scattering lengths from energy-level measurements on mesonic atoms are studied by means of a model calculation and are shown to be inadequate for most of the π^--mesonic atoms commonly considered. A simple empirical formula is obtained in place of the DGBT formula for the π^--mesonic atoms of the light nuclei. The DGBT formula is also examined for the case of the $K^- - {}^4He$ atom and is found to be a good approximation. (auth)

41947 EFFECT OF THE NONCOMPENSATED ELECTRON SHELL ON MUON POLARIZATION IN MESIC ATOMS. Tammet, Eve (Inst. of Cybernetics, Tallinn). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 18: 193-9(1969). (In Russian).

A three-particle system described by the spin Hamiltonian $H = A\overleftrightarrow{s}\overleftrightarrow{I} + B\overleftrightarrow{s}\overleftrightarrow{\sigma} + G\overleftrightarrow{\sigma}\overleftrightarrow{I}$ is considered. I, σ, and s are spins of the nucleus, the muon, and the noncompensated electron shell, respectively, and A, B, and G are hyperfine interaction constants. A general formula for the muon polarization is derived. A formula that is a good approximation for the actual values of constants is obtained. The results of numerical calculation are presented in a table. The muon polarization is shown to depend essentially on the nucleus and of the electron shell. (auth)

Collision Phenomena

Refer also to abstract 41852.

41948 (BMwF-FBK-69-18) PREFERENTIAL RECOMBINATION IN GASES AT HIGH PRESSURE. Koepp, R. (Goettingen Univ. (West Germany). Institut fuer Medizinische Physik und Biophysik). June 1969. 46p. (In German). Dep.

The effect of high pressure (200 atm) on the preferential recombination of ions in the irradiated gases oxygen, nitrogen, synthetic air, helium, and argon has been studied. The results indicate that attachment of electrons is no important precondition for preferential recombination since oxygen and air are showing the same proportion and nitrogen a reasonable amount of preferential recombination. In the rare gases helium and argon there has not been found any preferential recombination, as expected. (auth)

41949 (UCRL-50642) MEASUREMENTS OF EXCITED STATE POPULATION RATIOS OF ATOMIC HYDROGEN PRODUCED BY CHARGE EXCHANGE NEUTRALIZATION OF ENERGETIC PROTON BEAMS. McFarland, Robert H.; Futch, Archer H. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). June 20, 1969. Contract W-7405-eng-48. 20p. Dep. CFSTI.

Excited-state population ratios for atomic hydrogen were measured for energetic hydrogen ions neutralized by charge exchange with a number of different metallic vapors and permanent gases. Electric-field ionization techniques were used to determine excitation ratios. Detection of the energetic ions and neutrals was accomplished using partially depleted surface barrier detectors. Counting, using phase detection techniques in which an add-subtract scaler was phased to the signal, provided an improved signal-to-noise ratio. Two methods were used to provide desired targets. Metallic vapor and permanent gas thin targets of the order 10^{-5} μcm were produced as chopped neutral beams using conventional crossed-beam techniques. Gas cells were used for extending these measurements with permanent gases to targets up to seven orders of magnitude thicker. In the latter case the ion beam was interrupted electrically. Targets investigated were magnesium, potassium, barium, hydrogen, nitrogen, thallium, freon, water vapor, ammonia, and C_8F_{16}. (auth)

41950 POLARIZATION OF LYMAN-ALPHA RADIATION EMITTED IN ELECTRON–HYDROGEN ATOM COLLISIONS AND EMITTED BY METASTABLE H(2S) ATOMS IN WEAK ELECTRIC FIELDS. Ott, William Roger. Pittsburgh, Univ. of Pittsburgh, 1968. 199p.

Thesis.

The polarization of Lyman alpha radiation emitted in electron–hydrogen-atom collisions was measured in the energy range 10 to 700 eV. By measuring the ratio of the intensities of radiation whose electric vectors are respectively parallel and perpendicular to the electron beam, information on the relative populations of the magnetic substates in the excited 2p levels of the hydrogen atom was obtained. In addition, the polarization of Lyman-alpha radiation emitted by H(2s) atoms quenched in electric fields of 10 to 40 V/cm was both calculated and measured. The polarization of the impact radiation appears to have an energy dependence similar to that observed in selected lines of the helium, mercury, and alkali metal impact excitation spectra. At high energies the polarization fraction goes negative and is closely described by the Born approximation and related 1st-order approximations. The experimental polarization fractions in the vicinity of threshold were compared with the predictions of Burke, Taylor and Ormonde who used the 1s–2s–2p close-coupling approximation with 20 correlation terms included to account for electron–electron interactions. Although the predicted resonance in the polarization function at threshold could not be observed, the dependence obtained by folding the electron energy distribution into the theoretical curve is in very good agreement with the data. The polarization of Lyman-alpha radiation emitted by H(2s) atoms in weak electric fields was measured to be −0.30 ± 0.02, in close agreement with the value of −0.329 calculated in 1st-order stationary state perturbation theory. The zero polarization prediction of Lichten is seen to be in error. The small discrepancy between experiment and theory may be due to hyperfine effects. The polarization of countable uv radiation emitted in electron–hydrogen molecule collisions was also measured in the energy range 12 to 200 eV. The polarization fraction was less than 0.10 except near threshold where the emitted radiation is probably due to the excitation of electronic molecular states. (TSS) (Diss. Abstr.)

41951 ENERGY SPECTRUM OF THE SECONDARY ELECTRONS AND THE FLUORESCENT EFFICIENCY OF ELECTRONS IN THE 3914-A BAND. Khare, S. P. (Indian Inst. of Tech., Bombay. Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 17: 1257-68(June 1969).

The relation given by Vriens (1965) for total ionization cross sections was utilized to obtain ionization cross sections per unit energy range. For slow secondary electrons, the cross sections are in fair agreement with the first Born cross sections. It is further shown that for the production of fast secondary electrons the Møller cross section satisfactorily approximates the Born cross section. The expressions are employed to calculate the efficiency with which the kinetic energy of an electron, absorbed in air of uniform density, is converted into photon energy in the 3914-Å band. The results are compared with the available theoretical and experimental investigations. (auth) (UK)

41952 ELECTRON-IMPACT IONIZATION CROSS SECTION OF IONS. Mathur, K. C.; Tripathi, A. N.; Joshi, S. K. (Univ. of Roorkee, India). Phys. Rev., 184: 242-4(Aug. 5, 1969).

A comparative study has been made of the ionization cross section of ions Li^+, Na^+, K^+, Rb^+, Cs^+, Ne^+, N^+, and Mg^+ using different velocity distribution functions for the atomic electrons in the classical impulse approximation. The results are discussed in the light of the available experimental and theoretical results. (auth)

41953 MEASUREMENT OF SPIN-EXCHANGE CROSS SECTIONS FOR ^{133}Cs, ^{87}Rb, ^{85}Rb, ^{39}K, AND ^{23}Na. Ressler, N. W. (Ford Scientific Lab., Dearborn, Mich.); Sands, R. H.; Stark, T. E. Phys. Rev., 184: 102-18(Aug. 5, 1969).

Measurements to determine the spin-exchange cross section for collisions between like alkali metal atoms are reported. The spin-exchange cross section is determined for ^{133}Cs, ^{87}Rb, ^{85}Rb, ^{39}K, and ^{23}Na. The lifetime of the alkali metal atoms in the Zeeman sublevels of the ground-state hyperfine levels is dominated by spin-exchange collisions. The spin-exchange collision rate is therefore reflected by the line width of the microwave absorption spectrum observed in the magnetic dipole transitions between various ones of the Zeeman sublevels. The measurements employed an X-band electron paramagnetic resonance spectrometer. The alkali metal was distilled into a sample bulb, which was placed inside a Dewar in a resonant cavity. The bulb was then heated to a temperature corresponding to an equilibrium vapor density of approximately 10^{15} alkali metal atoms/cc and the microwave absorption spectrum was recorded. In order to relate the spin-exchange rate to a cross section, it is necessary to determine the alkali metal density. This was done by comparing the intensity of the alkali EPR absorption to that of a weighed and oriented copper sulfate crystal. For ^{133}Cs and ^{87}Rb, interpretation of the line-width data is complicated by the fact that the transitions occur in a region where there is appreciable mixing of the high-field spin states by the hyperfine interaction. A density-matrix description of spin exchange that corrects for this intermediate field mixing is discussed, and the corrections are applied to the measured cross sections for two transitions in ^{133}Cs and ^{87}Rb. Relative cross sections, referred to that of ^{23}Na, are also given. (auth)

41954 IMPACT-PARAMETER CALCULATION OF HYDROGEN–HYDROGEN DOUBLE-EXCITATION COLLISIONS. Levy II, H. (Smithsonian Institution Astrophysical Observatory, Cambridge, Mass.). Phys. Rev., 184: 97-102(Aug. 5, 1969).

Cross sections for the double-excitation collisions H(1s) + H(1s) → H2lm) + H(2l′m′) are calculated over the range of incident energy 6.25 keV to 3.0 MeV by means of the impact-parameter method. The first Born, distorted Born, and two-state approximations are employed. At low incident velocities, the inclusion of distortion terms decreases all cross sections below the first Born values. At high incident velocities, the distorted Born cross sections for excitation of the projectile atom to the $2p_0$ state exceed the Born values, while all other distorted Born sections approach the Born values from below. Back coupling from the final state to the initial state has negligible effect on the double-excitation cross sections. The polarization of the radiation emitted from the excited H(2p) projectiles is calculated for the double-excitation collisions and found to dominate the polarization for incident energies exceeding 25 keV. (auth)

41955 DENSITY EFFECT IN EQUILIBRIUM CHARGE-STATE DISTRIBUTIONS. Ryding, G.; Wittkower, A.; Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). Phys. Rev., 184: 93-6(Aug. 5, 1969).

Cross sections for single and multiple electron capture and loss have been measured for iodine ions in hydrogen at 4.50 MeV. Values were determined from the initial behavior of charge-fraction growth curves under thin-target conditions. Equilibrium charge-state fractions F_i were then calculated from the measured cross sections, and these values were compared with the fractions measured directly in a dense target. It is concluded that when multiple collisions occur, excited states in the projectile influence the effective charge-changing cross sections. Consequently measured values of the "equilibrium" charge-state fractions depend in a complex way upon the excited-state lifetimes and the target density. In this experiment, the mean charge calculated from cross-section values was 1.98, whereas, the measured mean charge was 2.33. (auth)

41956 FADDEEV EQUATIONS FOR ATOMIC PROBLEMS. II. DETERMINATION OF COLLISION AMPLITUDES. Chen, Joseph C. Y.; Chung, Kwong T.; Kramer, Paul J. (Univ. of California, San Diego, La Jolla). Phys. Rev., 184: 64-81(Aug. 5, 1969).

The method for solving the Faddeev equations for atomic problems proposed in Paper I of this series is reexamined using a new separable representation for the off-shell two-body amplitude. Specific details for the determination of the collision amplitudes are worked out. A new set of reduced equations with proper inhomogeneous terms is obtained for cases with identical particles (electrons). As an illustrative example, the phase shift for low-energy electron scattering by a hydrogen atom is calculated and compared with that calculated from conventional methods. In Appendix A, the possibility of applying the Faddeev equations to heavy-particle reactions using approximate or phenomenological atom–atom pair interactions is investigated. (auth)

41957 DIFFERENTIAL ELASTIC AND ROTATIONAL EXCITATION CROSS SECTIONS FOR ELECTRON–H_2 SCATTERING. Lane, Neal F. (Rice Univ., Houston, Tex.); Geltman, S. Phys. [illegible], 184: 46-51(Aug. 5, 1969).

Differential elastic and rotational-excitation cross sections for electron–H_2 scattering have been calculated in the close-coupling approximation with electron exchange neglected. The resulting elastic angular distributions are found to be in very good agreement with measurements. An apparent oscillation in the measured differential cross section for rotational excitation is not found in the calculation. (auth)

41958 ELECTRON LOSS IN HEAVY-BODY COLLISIONS. Victor, G. A. (GCA Corp., Bedford, Mass.). Phys. Rev., 184: 43-6(Aug. 5, 1969).

A simple theory based on a free scattering model and the Born approximation is used to describe the loss of electrons from an atomic system during high-energy impact with another atomic system. Calculations for electron loss by atomic hydrogen incident on helium, atomic nitrogen, and argon agree well with the Born approximation and the high-energy experimental data. At high energies the cross sections decrease as aE^{-1}, where E is the laboratory system energy, and for atomic hydrogen projectiles, a has the values 1.6×10^{-11}, 1.3×10^{-10}, and 4.7×10^{-10} cm^2 eV for targets of helium, atomic nitrogen, and argon, respectively. (auth)

41959 EXCITATION OF OSCILLATIONS AND BREAKUP OF DIATOMIC MOLECULES DURING ATOM–MOLECULE COLLISIONS IN A HIGH-TEMPERATURE GAS. Kuksenko, B. V.; Losev, S. A. (Moscow Univ.). Dokl. Akad. Nauk SSSR, 185: 69-72(Mar. 1, 1969). (In Russian).

In order to explain the mechanism of oscillation excitation and the breakup of diatomic molecules it is first necessary to determine the results of a separate collision, that is, to solve the dynamic problem at various initial states of the colliding particles, and then to consider the kinetic problem of determining the macroscopic characteristics of the gaseous system. An expression is assumed for the intramolecular potential involving the dissociation energy, the distance between nuclei of the oscillator, and a constant derived from spectroscopic data. Molecular transition probabilities between levels are then calculated for the known oscillatory levels of the molecule by using the correspondence principle of Bohr. The probability of molecule breakup was established in the same way. At level $j > 20$ the transition probability does not depend on temperature from 3000 to 20,000°K, and decreases with increasing level number. The probability of multiquantum transitions is large in this region. At a temperature of about 12,000°K the probability does not depend on the initial oscillatory energy of the molecule. A comparison of the calculated and measured values of the rate constants for the dissociation of oxygen molecules in an argon mixture shows good agreement as long as the initial rotation of the molecules and the electronic excitation of oxygen are taken into account. (TTT)

41960 SCATTERING OF HIGH-VELOCITY NEUTRAL PARTICLES. XVI. Ar–Ar, Ar–He, AND Ar–H_2. Colgate, S. O. (Univ. of Florida, Gainesville); Jordan, J. E.; Amdur, I.; Mason, E. A. J. Chem. Phys., 51: 968-72(Aug. 1, 1969).

Measurements are reported for the scattering of argon beams with energies between about 200 and 1500 eV by room-temperature argon, helium, and hydrogen. Two separate investigations in essentially the same apparatus are involved, and interaction potentials are derived for Ar–Ar and Ar–He at internuclear distances where scattering measurements have not previously been made. The Ar–Ar system was studied in both investigations, and the combined results are represented by $V(r) = 3.25 \times 10^3/r^{9.97}$ eV at 1.96 Å < r < 2.41 Å. There is good agreement between this result and potentials from other scattering measurements and shock compression of liquid argon. One series of new measurements was made for Ar–He. The derived potential is $V(r) = 22.2/r^{5.42}$ eV at 1.40 Å < r < 1.81 Å, which agrees well with other scattering results and with measurements of mutual diffusion coefficients at elevated temperatures. A combination of He–He potentials obtained from scattering with the present Ar–Ar results leads to a derived He–Ar potential in good agreement with that obtained from the direct measurements. One series of measurements was made for Ar–H_2, and the resulting potential is $V(r) = 159/r^{6.28}$ eV at 1.81 Å < r < 2.36 Å, which is about a factor of 2 higher than that derived from previous measurements on He–He, He–H_2, and Ar–Ar. It is also higher by about the same amount than the Ar–H_2 potential derived from other scattering measurements on Ar–Ar and H_2–H_2. Mutual diffusion coefficients for Ar–H_2 at elevated temperatures also suggest that this potential is high. The present potential for Ar–Ar agrees well with theoretical calculations based on a delta-function model and a statistical (Thomas–Fermi–Dirac) model. The Ar–He potential also agrees with calculated potentials based on these models and with that obtained from ab initio Hartree–Fock calculations. (auth)

41961 SIMPLE MODEL FOR VIBRATIONAL TRANSFER IN ION–MOLECULE CHARGE-EXCHANGE EXCITATION. Lipeles, Martin. (North American Rockwell Corp., Thousand Oaks, Calif.). J. Chem. Phys., 51: 1252-3(Aug. 1, 1969).

In data presented on excitation of CO^+ produced by collisions of argon ions of 1000 eV with CO gas, lower vibrational states show enhanced excitation compared to that expected from the Franck–Condon principle. When distorted Franck–Condon factors were calculated on the assumption that when the ion has reached the vicinity of the neutral molecule the latter's ground vibrational state has adjusted to the presence of the ion, much better agreement between theory and experiment was obtained. Calculations on excitation of the N_2^+ first negative band system by slow ions gave similar results. (A.G.W.)

41962 QUANTUM DYNAMICS OF THE COLLINEAR (H,H_2) REACTION. McCullough, Edward A. Jr.; Wyatt, Robert E. (Univ. of Texas, Austin). J. Chem. Phys., 51: 1253-4(Aug. 1, 1969).

Preliminary results are presented for the quantum dynamics of a model exchange reaction, H + H_2, in which all atoms are constrained to a line. The following observations are made: (1) the total reaction probability approaches 0.58 as $t \to \infty$; (2) curvature of the reaction path evidently plays a dominant role; (3) the direct interaction reaction mechanism is confirmed; (4) multiple crossings of the symmetric stretch (SS) line are observed; and (5) the reaction is not adiabatic with respect to the SS vibrations. (A.G.W.)

41963 CROSSED-BEAM STUDY OF IONIZATION OF Cs BY Br_2. Helbing, R. K. B.; Rothe, E. W. (General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys., 51: 1607-9(Aug. 15, 1969).

The velocity dependence of the relative cross section for the formation of Cs^+ from Cs and Br_2 has been measured in the cm energy range 1.5 to 16.5 eV. A crossed-molecular-beam technique was used. The threshold energy is 1.66 ± 0.1 eV (cm). This leads to a nominal value of 2.23 ± 0.1 eV for the electron affinity of Br_2. A maximum cross section is found near 6 eV. (auth)

41964 EXCITATION OF HELIUM BY PROTONS AND ELECTRONS. Van Den Bos, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 42: 245-61(Apr. 21, 1969).

Generalized oscillator strengths and cross sections for excitation of helium by protons and electrons have been calculated using Born approximation. Transitions from the ground state to all n = 2, 3, 4 singlet states have been considered, including some substate transitions. Three types of ground state wave functions have been employed: the one-parameter Hylleraas function, an exponential fit to the Hartree-Fock function, and a variationally determined Eckart function. The final states are linear combinations of products of hydrogenic wave functions. It is shown that the different wave function combinations give rise to largely different excitation functions, but that the combination with HF gives, except for n^1S, results that compete favorably with results obtained using much more accurate wave function combinations. (auth)

41965 ELECTRONIC CROSS SECTIONS AND MACROSCOPIC COEFFICIENTS. 1. HYDROGEN AND RARE GASES. Laborie, P.; Rocard, J.-M.; Rees, J. A. Paris, Dunod, 1968. 222p. (In English and French).

A collection of experimental data on electron reactions with hydrogen and the rare gases is presented. Cross sections for elastic and inelastic scattering, excitation of various energy levels, total and partial ionization, electron attachment and detachment, and momentum transfer are included. Macroscopic coefficients given are drift velocity of electrons in uniform electric fields, ratio of diffusion coefficient to mobility of electrons, and the primary Townsend ionization coefficient. (A.G.W.)

41966 FIRST BORN APPROXIMATION CROSS SECTIONS FOR ELECTRON LOSS FROM FAST HYDROGEN ATOMS PASSING THROUGH ATOMIC HELIUM AND FAST HELIUM ATOMS PASSING THROUGH ATOMIC HYDROGEN AND HELIUM. Bell, K. L.; Dose, V.; Kingston, A. E. (Queen's Univ., Belfast). J. Phys., B (London), 2: 831-8(Aug. 1969).

The first Born approximation is used to calculate cross sections for one-electron loss from fast atoms A passing through atomic targets B for the following colliding partners (A,B): (H,He), (He,H), and (He,He). Full account is taken of double transitions and the calculations are performed using length and velocity formulation values of the helium matrix elements. Comparison is made with available experimental data, and for the case (H,He) excellent agreement is obtained at high impact energies. Further experimental measurements are desirable for (He,H) and (He,He). (auth) (UK)

41967 RESONANCE CHARGE TRANSFER IN He^{2+}–H(1s) COLLISIONS. Malaviya, V. (Queen's Univ., Belfast). J. Phys., B (London), 2: 843-50(Aug. 1969).

The resonance charge-transfer cross sections for the collision process $He^{2+} + H(1s) \rightarrow He^{+}(2s,2p) + H^{+}$ was evaluated in the atomic two-state and five-state approximations of the impact-parameter method. Momentum transfer was taken into account by the procedure described by Cheshire in 1967. The total and individual cross sections obtained in the five-state approximation exceed the corresponding cross sections obtained in the two-state approximation. (auth) (UK)

41968 RESONANCE CHARGE TRANSFER BETWEEN PROTONS AND EXCITED HYDROGEN ATOMS. I. QUANTAL TWO-STATE APPROXIMATION. Bates, D. R.; Reid, R. H. G. (Queen's Univ., Belfast). J. Phys., B (London), 2: 851-6(Aug. 1969).

The quantal two-state approximation is used to compute the cross sections for symmetrical resonance charge transfer between protons and excited hydrogen atoms (with principal quantum number 5 or less). Allowance is made for the effect of the change in the velocity of relative motion during the encounter. In most cases this correction is appreciable if the impact energy is less than about 2.5 eV. (auth) (UK)

41969 RESONANCE CHARGE TRANSFER BETWEEN PROTONS AND EXCITED HYDROGEN ATOMS. II. CLASSICAL APPROXIMATIONS. Bates, D. R.; Reid, R. H. G. (Queen's Univ., Belfast). J. Phys., B (London), 2: 857-68(Aug. 1969).

Symmetrical resonance charge transfer between a proton and an excited hydrogen atom is treated classically, the three constants of the classical motion of the electron in a static two-center potential being chosen so as to ensure the closest possible match with the relevant quantal states. Approximate allowance is made for the quantal tunnel effect. The derived cross sections are in remarkably good agreement with the corresponding cross sections obtained from the quantal two-state approximation. (auth) (UK)

41970 SCATTERING OF ELECTRONS BY LITHIUM ATOMS. Burke, P. G. (Queen's Univ., Belfast); Taylor, A. Joanna. J. Phys., B (London), 2: 869-77(Aug. 1969).

The 2s,2p close-coupling equations for electron scattering by lithium atoms are solved from threshold to 54.4 eV. Both the elastic scattering and the 2s−2p excitation cross sections are evaluated. At very low energies the cross sections are shown to be dominated by resonances. At energies between 1 and 10 eV the total cross section can be compared with experiment. Any lack of agreement cannot be explained simply by the slow convergence of the close-coupling approximation. The spin polarization cross section and the polarization of 2p−2s impact radiation are also calculated. Comparison of the latter calculation with experiment is satisfactory. (auth)

41971 ELECTRON-IMPACT IONIZATION AND EXCITATION CROSS SECTIONS OF ATOMS WITH TWO OUTER-SHELL ELECTRONS. Tripathi, A. N.; Mathur, K. C.; Joshi, S. K. (Univ. of Roorkee, India). J. Phys., B (London), 2: 878-84(Aug. 1969).

The binary-encounter model incorporating exchange as developed by Vriens (1966) is used to calculate the cross sections for the excitation of the first excited singlet and triplet states of Hg, Cd, and Zn, and the ionization cross sections for Hg, Cd, Zn, Ca, Mg, and Be. For both excitation and ionization a quantal momentum distribution function for atomic electrons is used. The calculations are compared with the available experimental and theoretical results. (auth) (UK)

41972 DETACHMENT IN COLLISIONS OF H AND H^-. Browne, J. C. (Univ. of Texas, Austin); Dalgarno, A. J. Phys., B (London), 2: 885-9(Aug. 1969).

Semiclassical calculations are carried out for the processes of associative detachment $H + H^- \rightarrow H_2 + e$ and of collisional detachment $H + H^- \rightarrow H + H + e$ based upon values of the real and imaginary parts of the complex adiabatic potential computed by Bardsley, Herzenberg and Mandl (1966) and upon semiempirical values derived by Chen and Peacher (1968). The experimental data at high velocities lend support to the theoretical predictions of Bardsley et al., but the argument is inconclusive because of possible nonadiabatic contributions. It is pointed out that it may be possible to resolve the question by an experimental investigation of isotope effects at high velocities. (auth) (UK)

41973 PRODUCTION OF A LOW-ENERGY POLARIZED ELECTRON BEAM. Wilmers, M.; Haug, R.; Deichsel, H. (Univ., Mainz). Z. Angew. Phys., 27: 204-6(July 8, 1969). (In German).

Beams of slow polarized electrons are produced by scattering of 6.75-eV electrons by a mercury atomic beam. Electron energy is varied by decelerating the electrons after scattering. Nearly parallel beams of polarized electrons with degree of polarization of $p = 0.272 \pm 0.012$ and current up to 2×10^{-6} A are obtained in the energy range 0.2 to 5 eV. (auth)

41974 APPROXIMATION FORMULAE FOR THE IONIZATION CROSS SECTION OF THE K-SHELL BY ELECTRON IMPACT. Hink, W.; Jessenberger, J.; Ziegler, A. (Univ., Wuerzburg, Ger.). Z. Phys., 226: 463-8(1969). (In German).

Burhop's nonrelativistic result for the ionization cross section of the K shell was recalculated. The remaining integrations over the change of momentum and the momentum of the ejected electron were done numerically especially for elements of low atomic number. The ionization function of the various elements normalized to unity at the maximum shows very small variation with atomic number. This universal behavior of the ionization function was used to construct simple approximation formulas. (auth)

41975 CALCULATION OF THE TOTAL COLLISION CROSS SECTION OF H_2−Ar FOR A PARTICULAR ROTATIONAL j, m_j-STATE OF THE H_2-MOLECULE. Reuss, J.; Stolte, S. (Katholieke Univ., Nijmegen, Netherlands). Physica, 42: 111-23(Apr. 1, 1969).

The effect of angular dependent terms in the intermolecular potential of the system H_2−Ar is investigated in a close-coupling and a distorted-wave calculation. The contributions from attractive and repulsive terms are compared. The use of WKB wave functions in the distorted-wave approximation is discussed. (auth)

41976 INVERSION PROBLEM IN ATOM-ATOM SCATTERING IN WKB APPROACH. Vollmer, G. (Institut fuer Theoretische Physik, Freiburg i. B.). Z. Phys., 226: 423-34(1969).

The WKB phase of a scattering problem including high angular momenta can be written as a Jeffreys-Born integral, $\delta^{WKB}(\beta,K) = -(A/2K)\int_{\beta}^{\infty}[Q(t,K)tdt/\sqrt{t^2-\beta^2}]$ where $\beta = (1 + \frac{1}{2})/A$ is the reduced collision parameter. The quasi potential Q(t,K) defined by this formula is connected with the potential in an easily understandable way. Its introduction allows the solution of the inversion problem (in WKB approximation) by treating this formula as an integral equation for Q. It further permits the relation between potential and phase function. The evaluation of experimental atom−atom scattering data, using a phase function with seven parameters is given as an example of use of potential parameters. Potentials leading to observed differential cross sections thus can easily be computed. Computation times are about a factor 50 smaller than in conventional methods. (auth)

41977 CHARGE EXCHANGE OF LOW-ENERGY PROTONS AND DEUTERONS IN ALKALI-METAL VAPOURS. Gruebler, W.; Schmelzbach, P. A.; Koenig, V.; Marmier, P. (Eidgenossisches Technische Hochschule, Zurich). Phys. Lett., 29A: 440-1(June 30, 1969).

Charge exchange of protons and deuterons incident upon the alkali-metal vapors Cs, K, Na, and Li was investigated in the energy range of 1 to 20 keV. Yields of negative-charge components are presented. (auth)

41978 IONIZATION BY INELASTIC COLLISIONS OF A TRIATOMIC MOLECULAR JET OF HIGH-ENERGY HYDROGEN ON A TARGET OF DEUTERIUM. Devienne, F. Marcel (Laboratoire de Physique Moleculaire des Hautes Energies, Alpes-Maritimes, France). Compt. Rend., Ser. B, 268: 1303-6(May 19, 1969). (In French).

By the inelastic collision of high-energy hydrogen molecules with a deuterium target one obtains the ions: H_3^+, H_2^+, H_1^+, H_1^-, and H_2^-. The proportion of each of these ions depends on several parameters, in particular, the energy of the molecular jet. (tr-auth)

41979 INELASTIC COLLISIONS OF ATOMS IN THE CLASSICAL APPROXIMATION. Dubner, V. M.; Komarovskaya, N. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 26: 8-12(Jan. 1969).
Translated from Opt. Spektrosk., 26: 16-24(Jan. 1969).

The classical approximation of the theory of collisions is applied to inelastic collisions of two atoms. The general expression for the total and transport cross sections expressed in terms of cross sections for elastic or inelastic electron scattering by the impinging atom is obtained and analyzed. It was found that in many important cases it is necessary to know only the asymptotic form of this cross section. It was shown that the classical approximation yields a qualitatively correct asymptotic form and the threshold behavior of cross sections. An essential dependence of the results on the form of the distribution function of the relative motion of the atom and the target is pointed out. As an example, the cross section for excitation and ionization of a hydrogen-like atom in collision with a "hard-sphere" atom was calculated. It was shown that the position of the maxima of cross sections is in agreement with the Massey criterion. (auth)

41980 EFFECTIVE CROSS SECTIONS FOR EXCITATION OF HELIUM FROM THE 2^1S STATE BY ELECTRON IMPACT. Ionikh, Yu. Z. Opt. Spectrosc. (USSR) (Engl. Trans.), 26: 15-17(Jan. 1969).

Translated from Opt. Spektrosk., 26: 31-5(Jan. 1969).

The ratios of the maximum values of the effective cross sections for electron-impact excitation from the 2^1S state to the maximum cross sections for excitation from the ground state have been determined for ten levels of helium by a technique that consists of radiative depletion of the 2^1S level of helium in a discharge, including several assumptions on the shape of the excitation function of the helium levels from the 2^1S state. An estimate of the relative efficiency of excitation of helium levels from the 2^1S state in a discharge is made. (auth)

Atomic Theory

Refer also to abstract 42719.

41981 (AD-683386) PARTIAL EXCITATION IN WAVE MECHANICS. Report on Quantum Mechanics. Deer, James W. (Electronic Specialty Co., Portland, Oreg. Electronics Div.). Dec. 23, 1965. 26p. CFSTI.

By reinterpreting expectation value as effective value, a wave mechanics is obtained that contains spontaneous emission explicitly. This implies a nonquantized electromagnetic field, and allows the bound electron to take on a continuous range of energy values. Radiation reaction force then occurs on absorption, but not on emission. It is argued that present experimental evidence does not exclude this possibility. An experiment is given for making a positive test of the predicted phenomenon. This involves a beam of sodium atoms, deflected by means of illumination from the side by a sodium lamp. The beam of atoms is collected on a flat surface for analysis of the distribution pattern. Nominal deflection angle is 3×10^{-5} radians. (auth)

41982 ANALYTIC INDEPENDENT-PARTICLE MODEL FOR ATOMS. Green, Alex E. S.; Sellin, D. L.; Zachor, A. S. (Univ. of Florida, Gainesville). Phys. Rev., 184: 1-9(Aug. 5, 1969).

A simple analytic electron–atom independent-particle model (IPM) potential for use in phenomenological studies is examined. The potential is given by $V(r) = 2(NT - Z)/r$, $T = 1 - [(e^{r/d} - 1)H + 1]^{-1}$, where Z is the number of nuclear protons, N the number of core electrons, and Rydberg units are used. The adjustable parameters d and H are evaluated using (1) Thomas–Fermi screening functions, (2) Herman and Skillman Hartree–Fock–Slater (HS–HFS) screening functions, (3) HS–HFS eigenvalues, (4) Hartree–Fock eigenvalues, and (5) experimental separation energies. Good agreements with HS–HFS eigenvalues and screening functions for electrons in neutral atoms is obtained if $H = d\alpha N^{0.4}$, where d is adjusted for each element and $\alpha = 1.05$ for HFS and 1.00 for HF models. The success in fitting energy values and screening functions suggests that the potential embodies exchange and possibly correlation effects. Applications of the model to excited states and elastic and inelastic collisions are discussed. (auth)

41983 RADIATIVE EFFECTS IN SEMICLASSICAL THEORY. Crisp, Michael Dennis. St. Louis, Washington Univ., 1968. 82p. Thesis.

It has been generally believed that spontaneous decay and the Lamb shift could only be calculated by quantizing the electromagnetic field, because they are due to vacuum fluctuations. This thesis shows that it is not necessary to quantize the field. By solving Maxwell's equations simultaneously with Schrödinger's or Dirac's equation, one obtains both spontaneous decay and level shifts very similar to the Lamb shift. In the thesis the state of an atom in an optical field is represented as a system point on a unit sphere as is done in magnetic resonance theory. This is extended to give a graphical representation of such phenomena as optical pumping and stimulated emission in a many-level system. Study of the resulting equations leads to a number of new predictions concerning resonance radiation and quenching of one transition by the onset of another, which are capable of being tested experimentally and which should be important in the dynamics of laser operation. (Diss. Abstr.)

41984 SYMMETRY-ADAPTED SECOND-ORDER ENERGY. SOME COMMENTS AND RESULTS FOR H_2^+. Braendas, E.; Goscinski, O. (Uppsala Univ.). J. Chem. Phys., 51: 975-83(Aug. 1, 1969).

Interrelationships between rigorous upper and lower bounds to the second-order energy in several schemes are discussed. The validity of a formula of the type $E \leq E_0 + \epsilon_1 + \lambda^{-}\epsilon_2$ is further extended to the approximate, symmetry-adapted case. Results for H_2^+ show that the linear series $E_0 + \epsilon_1 + \epsilon_2$ obtained in the van der Avoird scheme [J. Chem. Phys., 47: 3649(1967)] actually crosses the exact energy, being above it at larger distances. (auth)

41985 IMPROVED QUANTUM THEORY OF MANY-ELECTRON SYSTEMS. V. THE SPIN-COUPLING OPTIMIZED GI METHOD. Ladner, Robert C.; Goddard III, William A. (California Inst. of Tech., Pasadena). J. Chem. Phys., 51: 1073-87(Aug. 1, 1969).

The previously developed GI methods have an arbitrary aspect since they are based on a particular representation of the symmetric group. Here this arbitrariness is removed by optimizing the representation, that is, optimizing the spin-coupling scheme simultaneously with the optimization of the orbitals. The resulting wave functions, called the spin-coupling optimized GI or SOGI wave functions, have all of the general properties of GI wave functions including the independent particle interpretation and are found as the solutions to a set of coupled differential equations that differ from the GI equations only in that the equations are constructed from a different representation of the symmetric group. This method was applied to the ground state and some excited states of Li, to the ground states of Be^+ and B^{++} and to the ground state of LiH. In each of these cases, it was found that the SOGI wave function was only slightly different from the GI wave function and led to very similar energies and other spatial properties. For the spin density at the nucleus, however, SOGI led to much better results. In order to illustrate the effects of spatial symmetry on the SOGI orbitals, the lowest ${}^1B_{1g}$, ${}^3A_{2g}$, and ${}^3E_u$ states of square H_4 and the ${}^2\Sigma_u^+$ state of linear symmetrical H_3 were examined. It was found that in three of these cases optimization of the spin representation is crucial to providing an adequate description of the state. To investigate how the SOGI method would describe chemical reactions, the SOGI wave functions were computed for several other nuclear configurations of the H_3 system along the reaction path. These calculations showed that the spin coupling changed significantly during the reaction $H_2 + H \rightleftharpoons H + H_2$ and that the variation of the SOGI orbitals provides a clear description of the changes in bonding that occur during this reaction. (auth)

41986 APPROXIMATION BY A SINGLE SLATER DETERMINANT. Smith, Vedene H. (Uppsala Univ.); Kutzelnigg, Werner. Ark. Fys., 38: 309-15(1968).

The single Slater determinant of n one-particle functions (spin orbitals) whose projection on a given antisymmetric n-particle wave function is a maximum, in general, is shown not to be the same as that constructed from the first n eigenfunctions (natural spin orbitals of the given one-particle density matrix. Instead, they are the first n eigenfunctions of a given transition density matrix. Some properties of these best overlap (Brueckner or exact self-consistent field) spin orbitals are discussed. (auth) (Sweden)

41987 SELF-CONSISTENT CALCULATION OF DYNAMIC POLARIZABILITY AND EXCITED p-STATE WAVE FUNCTIONS OF TWO-ELECTRON ATOM AND IONS. Mukherjee, P. K.; Sengupta, S.; Mukherji, A. (Saha Inst. of Nuclear Physics, Calcutta). J. Chem. Phys., 51: 1397-1416(Aug. 15, 1969).

Dynamic polarizability of He and isoelectronic ions has been calculated by a self-consistent variation–perturbation method. An interpolation relation has been obtained, which may be used to estimate the polarizability of ions in actual crystals under the influence of a radiation field. Representations of excited p states have been obtained. They compare favorably with more accurate calculations available. The advantage of the present method lies in its simplicity. It can be easily extended to atoms containing many electrons. (auth)

41988 MODIFIED WKB METHOD AS APPLIED TO THE THREE-DIMENSIONAL BOUND-STATE PROBLEM. Lu, Pao (Arizona State Univ., Tempe). J. Chem. Phys., 51: 1524-6(Aug. 15, 1969).

The modified WKB method applied to the bound-state problem as given by the author is extended to include several high-order terms. It is then applied to the single-electron-atom case. Here the three-dimensional harmonic-oscillator problem is taken as the solved part and the single-electron-atom problem as the part to be solved. It is shown that the successive terms in this modified WKB approximation consist of the series expansion that gives the correct eigenvalue. (auth)

41989 CONSOLIDATED CONFIGURATION-INTERACTION PERTURBATION METHOD: THE GROUND STATE OF BERYLLIUM. Barr, Tery L.; Simpson, William T. (Univ. of Oregon, Eugene). J. Chem. Phys., 51: 1526-33(Aug. 15, 1969).

A method is developed for consolidating the configuration-interaction method and Rayleigh–Schrödinger perturbation theory. The technique requires the existence of a more or less conventional unperturbed Hamiltonian but not its eigenfunctions. The method depends crucially upon a particular partitioning of terms among perturbed and unperturbed parts of the full Hamiltonian expressed in spectral representation, and leads to having some perturbation denominators significantly different from the Rayleigh–Schrödinger ones. The beryllium ground-state energy was calculated as a test. A hydrogenic basis was obtained by interacting the Shull–Löwdin discrete Laguerres over an appropriate one-electron Hamiltonian. A single screening constant was employed and a rather unique method was used to treat the (zero-order) degeneracy of the $|1s^2 2s^2\rangle$ and $|1s^2 2p^2\rangle$ functions. Some two-electron integrals were calculated by the method of Jones and Brooks and others by modifying the formula of Brown. The value −14.659 a.u. was obtained for the ground-state energy. This compares well with values obtained by more involved techniques. An analysis of the results shows that the method can be considered as generating the SCF and correlation energies in the normal course. (auth)

41990 NONORTHOGONAL NATURAL ORBITALS FROM OPEN-SHELL CONFIGURATION-INTERACTION CALCULATIONS. Weltin, E.; Heaton, Marie (Univ. of Vermont, Burlington). J. Chem. Phys., 51: 1576-80(Aug. 15, 1969).

The natural orbitals can be defined as the set of one-particle functions in which the spin-free one-density matrix is diagonal with the occupation numbers as diagonal elements. For an open-shell approximate wave function based on nonorthogonal one-electron orbitals the one-particle overlap matrix S in general does not commute with the Hermitian matrix D in $\gamma(1;\,1') = \Sigma_{i,j}\varphi_i(1)d_{ij}\varphi_j^*(1')$. In this case two consistent sets of natural orbitals, the conventional orthonormal and nonorthogonal set, are obtained. If D and S commute, the two sets are shown to be identical and orthonormal. For an intermediate-state multiconfiguration wave function of CH^+ it was found that the natural orbitals in both sets are clearly grouped into highly occupied orbitals and orbitals with low occupation numbers. Single configurations based only upon the highest occupied orbitals gave approximately the same energy (99.93% of the energy of the multiconfiguration wave function) in both sets. The total charge-density distribution, however, was approximated significantly closer by the single configuration in the nonorthogonal set. (auth)

41991 CORRESPONDENCE IDENTITIES. II. THE BOHR–SOMMERFELD IDENTITY FOR THE HYDROGEN ATOM. Norcliffe, A.; Percival, I. C. (Univ. of Stirling, Scotland). J. Phys., B (London), 1: 784-94(Sept. 1968).

The Bohr–Sommerfeld identity between the hydrogen energy levels given by the old quantum theory and the actual energy levels is explained. The quantum-dynamical solution of the hydrogen-like problem is obtained for bound states in terms of sums over classical paths using the symmetric representation of Fock. The classical analogue of the Fock theory of the hydrogen atom is discussed. Schwinger's expression for the Green function is obtained in a new form. (auth)

41992 EFFECTS OF ELECTRON–ELECTRON INTERACTION ON THE ONE-ELECTRON PROPERTIES OF ATOMS AND SOLIDS. Hedin, L.; Johansson, A.; Lundqvist, B. I.; Lundqvist, S.; Samathiyakanit, V. Inst. of Theoretical Physics, Goteborg). Ark. Fys., 39: 97-112(1969).

The one-electron spectra of atoms and solids are discussed taking the dynamic interaction between electrons into account. An approximation for the electron self-energy to lowest order in the effective screened interaction is used to describe core, valence, and externally injected electrons. Shifts and widths of the electron levels and additional structure in the spectral weight function are discussed using qualitative considerations as well as quantitative results. (auth) (Sweden)

Cosmic Radiation

Refer also to abstracts 41001, 41004, 41008–41010, 41060–41063, 41140–41142, 41870, 41877, 42554, and 42641.

41993 STUDY OF THE ANGULAR DISTRIBUTION OF SHOWER PARTICLES GENERATED BY μ-MESONS OF THE ENERGY E > 2.5 GeV. Kashkarov, L. L.; Gafurov, V. G.; Orifkhodzhaev, Ya. Kosm. Luchi, No. 10, 98-103(1969). (In Russian).

An experimental installation comprising a scintillation counter of μ-mesons has been used to study the angular distribution and the probability of the generation of secondary shower particles by the cosmic radiation high-energy μ-mesons at 3,860 m above sea-level. The peak intensity of the secondary particles is at the angle $\varphi = (45 \pm 10)°$. The intensity of these particles in relation to the vertical flux of μ-mesons of an energy above 2.5 GeV is about 15%. The correction for the angular distribution of μ-mesons is 30%. The energy of the secondary shower is estimated to be 140 MeV. (auth)

41994 OBSERVATION OF TRANS-IRON NUCLEI IN THE PRIMARY COSMIC RADIATION. Blanford, G. E. Jr. (Washington Univ., St. Louis); Friedlander, M. W.; Klarmann, J.; Walker, R. M.; Wefel, J. P.; Wells, W. C.; Fleischer, R. L.; Nichols, G. E.; Price, P. B. Phys. Rev. Lett., 23: 338-42 (Aug. 11, 1969).

Interleaved layers of nuclear photographic emulsion and plastic detectors, covering a total area of 21 m^2, were exposed to the primary cosmic radiation on high-altitude balloon flights. Flux values, in particles/m^2 sr sec, have been estimated to be $J(Z \geq 33) \geq 2.6 \times 10^{-5}$, $J(33 \leq Z \leq 40) \geq 1.9 \times 10^{-5}$, and $J(Z \geq 70) \gtrsim 1 \times 10^{-6}$. These values refer to the top of the atmosphere, after extrapolation through 1.5 g/cm^2 of detector and 3.5 g/cm^2 of atmosphere, for particles with magnetic rigidities above 5 GeV. (auth)

41995 INTENSITY OF THE SOFT X-RAY BACKGROUND FLUX. Bowyer, C. Stuart; Field, George B. (Univ. of California, Berkeley). Nature (London), 223: 573-5(Aug. 9, 1969).

A discussion is presented on the measurements of soft x rays from outside the Galaxy which have been published by groups at the University of California and at the Naval Research Laboratory. (auth) (UK)

41996 SOLAR DIURNAL ANISOTROPY OF COSMIC RAYS. Jacklyn, R. M.; Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Penn.). Nature (London), 223: 601-2(Aug. 9, 1969).

The solar diurnal anisotropy of cosmic rays is attributed to the bulk streaming of the cosmic-ray gas caused by the corotating interplanetary magnetic field "rigidly attached to the Sun." A relationship exists between the amplitude of the daily variation and the magnetic rigidity (R), particle speed (v) and bulk streaming velocity (a), and a neutron monitor with mean rigidity of response ~10 GeV and atmospheric threshold 1 GeV should be capable of observing an amplitude of ~0.7% extrapolated through the atmosphere to free space. Some new conclusions are presented on the modulation parameters from a comprehensive analysis of measurements over almost an entire solar cycle, using a variety of detectors responding to primary 1- to 200-GeV cosmic rays and spanning the range of rigidities expected to be affected by the solar modulation process. Changes in amplitude were found to be greater for detectors having higher mean rigidities of response. Although the steady-state phase determined with neutron monitors did not vary appreciably, marked changes up to 5 hr and in opposite directions, were shown in the other cases. These features are a consequence of both the higher energy of response and the special sensitivity of the west minus east vector to small changes in the spectral parameters of the cosmic-ray anisotropy. The parameters of the intensity modulation in free space can be deduced from measurements of amplitude and time of maximum obtained with the different detectors by calculations involving the response functions and asymptotic cones of acceptance appropriate to each detector. Data are given averaged over the period 1958–1966. The most probable value of Ru, consistent with reasonable weighting of the data from different detectors, is about 90 GeV, compared with the value 200 GeV or more generally assumed in analyses of the diurnal variation of the nucleonic component. Plots on a yearly basis indicated that Ru ranged from about 120 to 55 GeV. It is concluded that caution must be exercised in pursuing the consequences of streaming theory, particularly with regard to the customary assumption that amplitude of the diurnal modulation is independent of particle rigidity. (UK)

41997 OPTICAL POLARIZATION MEASUREMENTS OF PULSAR NP 0532. Cocke, W. J.; Disney, M. J.; Gehrels, T. (Univ. of Arizona, Tucson). Nature (London), 223: 576-8 (Aug. 9, 1969).

The linear polarization was found to be of the order of 15% and variable and the circular polarization less than 5%. (auth) (UK)

41998 THE RADIAL GRADIENT OF INTERPLANETARY RADIATION MEASURED BY MARINERS 4 AND 5. Krimigis, S. M. (Univ. of Iowa, Iowa City); Venkatesan, D. J. Geophys. Res., 74: 4129-45(Aug. 1, 1969).

A detector package on the Mariner 4 spacecraft, which was launched on a Mars-bound trajectory on November 28, 1964, included a shielded GM tube (detector C) whose threshold is about 50 to 55 MeV/nucleon for protons and alpha particles. By comparing the counting rate of detector Ç to that of a similar Earth-orbiting GM tube on the IMP-OGO series of spacecraft one finds the following: (a) As the difference in heliocentric longitude between the two spacecraft increases, there appear differences in the time and/or space development of a Forbush decrease. It is estimated that the Forbush decrease may be confined to a region of dimensions as small as 0.5 × 0.7 AU. (b) The gradient of particles in the interplanetary medium with energies above the detector energy threshold is (−14.4 ± 2)%/AU (i.e., directed toward the Sun), during the solar minimum period of 1964−1965. (c) Additional data from the Venus-bound Mariner 5 spacecraft and the Mariner 4 and IMP-OGO spacecraft during the latter part of 1967 are consistent with the 1965 results and show that the gradient may have increased in magnitude. (d) Based on the above results, it is shown that the interplanetary flux of particles of $E \gtrsim 50$ MeV/nucleon must in part be of solar origin. (e) It is argued that the gradient of galactic cosmic radiation of $E \sim 50$ MeV/nucleon cannot be measured even at the time of solar minimum, in the range 1.0 to 1.6 AU. (f) The astrophysical consequences derived by O'Gallagher (1967) regarding the $(R\beta)^{-1}$ dependence of the gradient and the size of the modulation region are now open to question. (auth)

41999 PRONOUNCED DIURNAL VARIATION IN COSMIC-RAY INTENSITY AS SEEN BY INCLINED MESON TELESCOPES. Briggs, R. M.; Hicks, R. B.; Standil, S. (Univ. of Manitoba, Winnipeg). J. Geophys. Res., 74: 4196-8(Aug. 1, 1969).

Recently Mathews et al. (1969) reported on enhanced diurnal variations as seen by various neutron monitors for the periods Feb. 1−6, 1967; Apr. 5−14, 1967; and Feb. 22−28, 1968. They concluded that for these periods, during which the geomagnetic activity was low and there were no Forbush decreases, the observed enhanced anisotropies in the equatorial plane were largely due to reduced intensities from directions 40 to 70° west of the Sun−Earth line. They further suggested that such variations might indicate solar activity on the hidden side of the Sun. The purpose of this note is to report on the observation of similar enhanced diurnal variations for these same time periods using two relatively narrow-angle, inclined meson telescopes that scan the equatorial plane and have their maximum response for much higher-energy primaries than do neutron monitors. (W.D.M.)

42000 COSMIC-RAY MUON-INDUCED ^{59}Fe IN COBALT. Takagi, Jinzaburo; Tanaka, Shigeo (Tokyo Univ.). J. Geophys. Res., 74: 3219-25(June 15, 1969).

^{59}Fe induced by cosmic-ray muons in cobalt was investigated. γ rays that can be assigned to ^{59}Fe were observed in reagents of cobalt that had been exposed both with and without a soil cover to cosmic rays at sea level as well as at a mountain altitude. Both the theoretical calculation and the analysis of the experimental results suggest that the activities observed at sea level are mainly due to ^{59}Fe formed by the nuclear capture of cosmic-ray negative muons with cobalt. The production rates of ^{59}Fe by muons have been evaluated to be 0.35 ± 0.14 (at sea level) and 0.33 ± 0.16 (at sea level with a soil cover of 200 g/cm^2) ^{59}Fe atoms/min kg Co. (auth)

42001 CHARGE SPECTRUM AND SOLAR-MINIMUM INTENSITY OF HEAVY ($Z \geq 3$) PRIMARY COSMIC-RAY NUCLEI AT 41°N. MAG. Fody, Sandor Alexander. St. Louis, Washington Univ., 1968. 142p.

Thesis.

It is during times of minimum solar activity that the galactic cosmic radiation reaching the earth is least altered by the interplanetary medium. The main purpose of this work is to study the fluxes and composition of the $Z \geq 3$ primary cosmic-ray nuclei observed during the 1965 solar minimum. Two large stacks of nuclear photographic emulsions, a total of 242 Ilford G5 pellicles of size 20 × 5 × 0.6 cm, were exposed to the primary cosmic radiation on a high altitude balloon flight over Texas, on April 24, 1965. The flight trajectory corresponded to a mean geomagnetic cutoff rigidity of 4.5 GV and the residual atmospheric pressure at ceiling altitude was 2.7 gm/cm^2. The duration of the flight was 9 hr 26 min, from the time of emulsion rotation upon reaching the ceiling to cut down. After processing, the plates were scanned along a line 1.1 cm below the top edge of the emulsion, and particle tracks 30° within the zenith and having a projected length of at least 5 mm per plate were accepted for analysis. Using standard nuclear-emulsion methods of charge identification, the total heavy-particle flux was found to be $J(Z \geq 3) = 11.5 \pm 0.5$ particles/m^2 ster sec. (TSS)(Diss. Abstr.)

42002 IDENTIFICATION OF THE NATURE OF IONIZING SECONDARY PARTICLES PRODUCED LOCALLY BY NEUTRAL COSMIC RAYS. Gnecco-Calvo, Francisco. Washington, D. C., Catholic Univ. of America, 1968. 39p.

Thesis.

A cosmic-ray component has been detected in a spark chamber and has shown a directional siderial effect. Efforts to identify the source as well as the nature of the detected particle are still under way. To this end the nature of the ionizing secondary particle was investigated. The particle was identified from its lifetime measurements which was done by the display of the electric pulses due to the particle itself and its decay product on the screen of an oscilloscope. The result of the measurement of the half-life gave a value very close to the universally recognized value for muons. This information together with data from ionization and scattering measurements and the energy spectrum of the decay product will provide definitive evidence for the identification of the neutral particle. (Diss. Abstr.)

42003 THE RADIAL AND AZIMUTHAL COMPONENTS OF COSMIC-RAY STREAMING IN INTERPLANETARY SPACE. Quenby, J. J.; Hashim, A. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 17: 1121-39(June 1969).

The second harmonic of the cosmic-ray daily variation may be explained by a symmetrical gradient rising away from the solar equatorial plane. Particles scattering across field lines into the equatorial plane under the influence of this gradient can give rise to a flow in the outward radial direction which will contribute to the diurnal wave. A model is calculated in which this flow is the sum of all contributions from the perpendicular gradient between the Earth and the Sun. The flow is proportional to $\epsilon = (K_{\perp}/K_{\parallel})$, the ratio of the perpendicular and parallel diffusion coefficients at 1 AU and using magnetic-field data it was estimated to be 6% of the solar-wind velocity at 10 GV in 1964, a figure to be compared with the best direct experimental estimate of 2 ± 2%. Using Parker's work on the reduction of the co-rotation component of cosmic-ray streaming as a function of ϵ which shows that the azimuthal component is very small at $\epsilon \rightarrow 0$ and $\epsilon \rightarrow 1$, but rises to a peak in between, curves showing the variation of the radial and azimuthal components are produced as a function of ϵ. Examination of the phase and amplitude changes in the first harmonic of the daily variation from 1937 to 1966 shows that only part of the variation can be due to changes in the upper cut-off of modulation and a radial flow is required to explain the remaining variation at some epochs. The trend in the experimental results when radial and azimuthal flow components are assumed to exist with a constant upper cut-off rigidity is in fair agreement with the predicted curves. A similar trend is found in 1965−1967 when phase and amplitude are considered as a function of A_p. (auth) (UK)

42004 DIURNAL VARIATION IN LOW-ENERGY COSMIC-RAY CUTOFFS. Barcus, J. R. (Univ. of Denver). Planet. Space Sci., 17: 1173-81(June 1969).

Balloon observations are presented of the daily variation in the flux of nuclear γ rays which were produced by proton bombardment of the terrestrial atmosphere over Byrd Station, Antarctica ($L \approx 7$) during the January−February 1967 solar particle events. This modulation is interpreted as the result of a local geomagnetic-time dependence for the cutoff of the solar proton influx at low energies (≈1 to 30 MeV). The observations are compared with predictions of existing theory and, while the predicted effect is confirmed qualitatively, significant discrepancies in quantitative detail are evident. Lack of better agreement lies, most probably, in the assumed simplicity of the magnetospheric models in use. (auth)(UK)

42005 EMISSION OF RADIO PULSES FROM COSMIC-RAY EXTENSIVE AIR SHOWERS. Bray, A. D. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 223: 723-5(Aug. 16, 1969).

Attempts to ascertain the mechanism by which the ionised disk of a cosmic-ray EAS may emit a radio pulse, as observed at frequencies between 22 and 560 MHz, are discussed, and it is stated that no conclusive result has yet been found. The high intensity requires that there must be coherent radiation from a spatial distribution of charge, and it has been suggested that this occurs as a result of the separation of charges of opposite sign in the Earth's magnetic field, or by the selective absorption of positrons, leaving an excess negative charge. Experiments at 22 MHz and 30 MHz supported the magnetic separation hypothesis, but other experiments at 44 MHz indicated that the magnetic field may be unimportant. The present communication describes a further experiment at 42 MHz which suggests that the relative importance of the two mechanisms may differ between large and small radio pulses. The radio pulses received from showers arriving in directions along and across the field were compared; the pulses were received on an antenna sensitive in both directions, and an array of particle detectors which discriminated between showers arriving in the two directions was employed. The experimental set-up and its operation are described in detail. Twelve large pulses, from a recording of about 160 showers, were observed. The largest pulses were received predominantly from the north, as expected from the effect of the Earth's magnetic field, but the ratio of total pulse power received from the north to that from the south was only 1.3, a much smaller ratio than would be expected from the behaviour of the large pulses. If the emission were governed entirely by the Earth's magnetic field the ratio would have been much higher, and for the smaller pulses it appeared that geomagnetic effects contributed only about 0.25 of the total emission. This is in marked contrast to the behaviour of the larger pulses and also to the lower frequency results, but in general agreement with the lack of evidence for magnetic effects. It is recognised, however, that experimental measurements may be considerably influenced by the method of analysis. The results suggest that both radiation mechanisms are important and produce different pulse-height distributions, and the simplest explanation seems to lie in the different atmosphere heights at which large and small showers develop. (UK)

42006 UHF RADIO PULSES FROM THE ZENITH ASSOCIATED WITH EXTENSIVE AIR SHOWERS. Fegan, D. J.; Jennings, D. M. (University Coll., Dublin). Nature (London), 223: 722-3(Aug. 16, 1969).

Radio pulses associated with extensive air showers have been detected in many experiments at frequencies between 3 and 75 MHz, but none of the present emission theories would predict a detectable radio signal from EAS's at frequencies above 100 MHz. In recent experimental work, however, the detection of pulses at frequencies between 200 and 520 MHz has been reported. The present authors describe observation based on an investigation near the zenith, using scintillation counters as a trigger system, and interrogating the output of a low noise radio received (ν = 550 MHz, $\Delta\nu$ = 20MHz). Details of the experimental set-up and its operation are given. The observations were based on five months of continual night-time operation between July and November 1968, during which time 6,578 showers were detected. Results are given in histograms form, and supported the other recent findings. (UK)

42007 INTERCHANGEABILITY OF THE NUCLEON–PION INTERACTION PARAMETERS IN COMPUTING THE MEAN CHARACTERISTICS OF EXTENSIVE SHOWERS. Dedenko, L. G. Kosm. Luchi, No. 10, 62-4(1969). (In Russian).

Mean characteristics of extensive showers are computed for various observation levels for different values of the mean inelasticity factor, nucleon-pion interaction cross section, and various values of complete multiplicity of secondary particles. The possibility of the interchange of the said nucleon-pion interaction parameters in calculating mean extensive shower characteristics is considered. (auth)

42008 ATMOSPHERIC TEMPERATURE EFFECTS UPON VARIOUS MEAN CHARACTERISTICS OF THE EXTENSIVE SHOWERS. Dedenko, L. G. Kosm. Luchi, No. 10, 60-1(1969). (In Russian).

The mean values of the extensive air shower characteristics were computed for different temperatures of the isothermic atmosphere for different observation levels. The temperature effects in conducting calculations of the muon number counts are analyzed. (auth)

42009 AN ENERGY SPECTRUM OF PRIMARY COSMIC RAY HELIUM NUCLEI DETERMINED BY MEANS OF NUCLEAR EMULSIONS EXPOSED IN SOUNDING ROCKET FLIGHTS. Olsson, P.-I.; Kristiansson, K. (Univ. of Lund, Sweden). Ark. Fys., 38: 383-8(1968).

The energy spectrum of primary cosmic-ray helium nuclei was studied in two nuclear emulsion stacks, which were exposed in August 1962 in two sounding rocket flights from Kronogard in northern Sweden. The energies of the helium nuclei were determined by Coulomb multiple scattering measurements. The differential energy spectrum and the total flux of helium nuclei were compared with the results of other investigations. The experiment shows that the energy spectrum of galactic helium nuclei can be studied by means of nuclear emulsions exposed in sounding rocket flights with an exposure time of a few minutes. (Sweden)

Direct Energy Conversion

Refer also to abstracts 41529, 42261, and 42339.

42010 (CONF-670846–, pp 136-70) DIRECT ENERGY CONVERSION PROGRAMS AT NASA. Breitwieser, Roland (National Aeronautics and Space Administration, [Washington, D. C.]).

The various energy conversion devices studied by NASA are briefly described. These include the potassium–Rankine system, Brayton cycle, and thermionic converters. (M.O.W.)

42011 (CONF-670846–, pp 171-207) DIRECT ENERGY CONVERSION STUDIES WITH EMPHASIS ON THOSE INVOLVING NUCLEAR RADIATION. Miley, G. H. (Illinois Univ., Urbana).

The following topics are briefly discussed: (1) fission-electric cell, (2) direct collection studies and, (3) nuclear radiation for laser pumping. (M.O.W.)

42012 (EOS–4018-Q-2) DEVELOPMENT OF THERMIONIC CONVERTERS. Quarterly Progress Report No. 2. Jacobson, Dean; Hamerdinger, Randy (Electro-Optical Systems, Inc., Pasadena, Calif.). July 15, 1969. Contract 952255. 16p.

For Jet Propulsion Lab., Pasadena, Calif.

A thermionic converter with the following design parameters is being tested: a power density of 4 watts/cm^2 at 0.7v at an emitter temperature of 1400°C. Test results obtained at emitter temperatures of 1300°C, 1400°C, and 1500°C are shown. (M.H.R.)

42013 (EUR–4224) INFLUENCE OF OXYGEN ON THE THERMONIC EMISSION OF A (110) ORIENTATED TUNGSTEN SURFACE. Schins, H. E. J.; van Andel, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 20, 1968. 8p. Dep.

The thermionic emission of a tungsten single crystal emitter (110) was measured in an oxygen atmosphere. The saturation current was determined in the temperature range from 1600 to 2200°K in relation to the oxygen pressure (varying between 3.5×10^{-8} torr and 10^{-3} torr). The effective work function was plotted as a function of the reduced emitter temperatures (emitter temperature divided by a fictitious oxygen bath temperature). The results show the same trend as found by other investigators, i.e., the increase in effective work function caused by the adsorbed oxygen can be represented either by adsorption isotherms or isobars, or as a single function of reduced temperature. (auth)(Euratom)

42014 IONIZATION OF MERCURY VAPOR IN NUCLEAR REACTOR. Kramar, J. pp 178-83 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).

See CONF-681053.

The ionization effects of nuclear reactors on mercury vapor were experimentally studied previously with respect to the direct plasmodiffusion conversion of heat energy into electrical energy. The ionization effects were theoretically evaluated for a thermoemission energy converter filled with cesium vapor. The results showed that the temperature of the thermoelement does not correspond to that of the mercury temperature. The linear pattern of the V–A characteristic lines indicate that, in the current of the mercury vapor discharge tube, the current of the volume ionization exceeds considerably the current arising in the cathode. For a cesium energy converter filled with cesium at a pressure of one torr, it was concluded that the ionization effects would be considerably greater than that measured for mercury vapor. (J.S.R.)

42015 TWO-DIMENSIONAL INVESTIGATIONS ON MHD GENERATORS WITH REGARD TO THE HALL EFFECT. Bresgen, H.; Cap, F. (Univ., Innsbruck). Acta Phys. Austr., 28: 65-84(1968). (In German).

Previous two-dimensional analyses of MHD generators with respect to the Hall effect were limited to the case of periodic finite many-electrode pairs and σ = const., with special assumptions on the plasma streaming. A new calculation method is presented, free of these limitations. The method was applied to an individual electrode pair and to finite many-electrode pairs for σ = const., for σ = variable, and with consideration of the ion slippage. (J.S.R.)

42016 EFFECTS OF AUXILIARY DC DISCHARGES ON THE PERFORMANCE OF A LINEAR MHD GENERATOR USING POTASSIUM-SEEDED ARGON PLASMAS. Shirakata, Hirofumi; Hiramoto, Tatsumi; Yano, Syukuro (Japan Atomic Energy Research Inst., Ibaraki). Jap. J. Appl. Phys., 8: 772-9 (June 1969).

Experimental results are described concerning the effect of preionization by dc discharge parallel to the magnetic field on the performance of the linear MHD generator. Experiments were made with a blow-down facility, using a potassium-seeded argon or a K_2CO_3-seeded argon in the temperature range of 1600 to 1950°K at 1 atm and Mach number below 0.27. When the discharge was stable and uniform, the short-circuited current increased with increase in the applied discharge current, and the decrease in the nonuniformity of the electron density in the normal direction was indicated. However, the effective Hall parameter was not increased by the discharge. The enhancement in the electron density in the central flow region due to the discharge was concluded. However, the existence of the magnetically induced nonequilibrium state could not be verified. A discussion is made on the estimation of the recombination coefficient. (auth)

42017 FISSIONING URANIUM PLASMA FOR ROCKET PROPULSION. Atwater, Henry Foust. Gainsville, Fla., Univ. of Florida, 1968. 220p.

Thesis.

A fissioning uranium plasma for use as a high temperature self-sustaining energy conversion device is studied theoretically. The study is oriented with particular emphasis on the use of the fissioning plasma as a heat source for rocket propulsion systems, although the ideas and methods which are developed can also be applied to a closed cycle heating system which utilizes the fissioning plasma principle. The effects of coupling mechanisms between nucleonic and plasma properties of the fissioning plasma are identified and analyzed for a reference model. The model is based on a central fuel region of fully enriched uranium surrounded by a hydrogen coolant region, contained within a cylindrical graphite chamber. The uranium region serves as a heat source through liberation of radiant energy from fissioning uranium nuclei. The radiant heat transfer from the uranium plasma to the hydrogen coolant plasma is accomplished by seeding the coolant with a material which is sufficiently opaque to reduce the coolant-wall interface temperature below the melting point of graphite. The radial mixing of flowing uranium and hydrogen is simulated by use of analytic expressions. Numerical techniques are developed for the engineering analysis of the principal characteristics of the fissioning plasma reactor, under conditions of local thermodynamic equilibrium. The reference model study leads to several basic requirements which must be satisfied in order to develop an operable fissioning plasma reactor. The nuclear analysis of such problems as critical mass, reactivity balance, and kinetic behavior must treat both the fuel and coolant as plasma regions rather than ordinary gases. In order to sustain a critical uranium mass at the desired high temperatures, pressures as high as 1000 atmospheres will be required. In order to heat the relatively transparent hydrogen coolant and also to prevent melting of the graphite containment, the coolant will have to be seeded. Additional theoretical and experimental studies of plasma instabilities associated with the coaxial flow of uranium and hydrogen are needed to analyze such problems as system stability and fuel loss rate. Finally, a substantial high pressure, high temperature experimental program is needed to determine statistical weights and energy levels of the various uranium ions. (Diss. Abstr.)

42018 MHD POWER GENERATION: CURRENT STATUS. Dicks, J. B. (Univ. of Tennessee Space Inst., Tullahoma); Way, Stewart; Brogan, T. R.; Jones, M. S. Jr. Mech. Eng., 91: No. 8, 18-25(Aug. 1969).

The attainments, problems, and outlook for open-cycle MHD power plants for commercial applications are summarized. Closed-cycle and liquid metal systems are discussed briefly. (M.H.R.)

42019 THERMIONIC ENERGY CONVERTER. Langpape, Reinhart; Jester, Alfred (to Brown, Boveri and Cie Aktiengesellschaft). U. S. Patent 3,453,455. Priority date May 3, 1965, Germany.

A thermionic energy converter is described comprising a tube of insulating material and a plurality of thermionic energy converter cells sequentially longitudinally arranged within the tube. Each of these cells includes a cylindrical collector electrode disposed on the inner wall of the tube with a cylindrical emitter electrode disposed within the collector electrode. Each emitter electrode is spaced from and concentrically positioned with respect to its corresponding collector electrode. Each collector and emitter electrode of a cell are longitudinally spaced from the collector and emitter electrodes of adjacent cells, with each collector electrode of a cell connected to the emitter electrode of the adjacent. Respective pluralities of sheets are disposed between adjacent collector electrodes opposite the inner wall of the tube. Each of the pluralities of sheets include at least a pair of sheets which are spaced from and overlap each other. One of each pair of sheets is connected to one of two adjacent collector electrodes and the other sheet is connected to the other of two adjacent collector electrodes. A heater is contained within each of said emitter electrodes. (TSS)

42020 INFLUENCE OF VARIABLE THERMAL CONDUCTIVITY AND VARIABLE ELECTRICAL RESISTIVITY ON THERMOELECTRIC GENERATOR PERFORMANCE. Lee, Jerry S. (North Carolina State Univ., Raleigh). Energy Convers., 9: 91-7 (Aug. 1969).

Closed form analytical solutions are presented for the steady-state temperature distribution, power output, and thermal efficiency of a fully insulated thermoelectric power generator with variable thermal conductivity and electrical resistivity. It is assumed that the Seebeck coefficient remains constant. The thermal conductivity and electrical resistivity are assumed to be hyperbolic and logarithmic functions of temperature, respectively. Both maximum power output and maximum efficiency are considered, and the results are compared with a constant property analysis based on properties evaluated at the average temperature of the hot and cold junctions. The results show that both power output and efficiency increase as the slope of the resistivity vs. temperature curve increases. When the electrical resistivity is constant, variable thermal conductivity does not affect the maximum power output, but it does decrease the thermal efficiency. The constant property analysis yields a better approximation to the maximum power output and the maximum thermal efficiency as the product of the figure of merit (formed from properties evaluated at the average temperature) and the average temperature increases. The constant property analysis serves as a better approximation to the thermal efficiency than to the power output. (auth)(UK)

42021 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC APPARATU. Womack, Gerard Joseph (to Central Electricity Generating Board). British Patent 1,159,460. July 23, 1969. Filed Dec. 9, 1966.

It is stated that the electrodes and duct walls in conventional fossil fuel MHD apparatus are subject to erosion due to electrochemical and electrothermal effects. The object of the system described is to provide an improved form of electrode and wall construction to reduce such erosion. The duct walls and/or electrodes are formed, at least in part, of modular elements each consisting of a permeable membrane through which a cool gas or liquid is passed into the duct; the membrane face exposed to the duct gases is surrounded by a metal holder, the holders being insulated from one another and having channels through which the coolant is circulated. The modular elements may be of square or strip form and fabricated from ZrO_2, MgO, or Al_2O_3; they may also be reinforced by carbon or refractory metal fibers. They may also be formed of sintered metal, such as W, Ta, or stainless steel. Either air or oxygen for combustion of the fuel, or a combustible gas, may be passed through the membrane. (UK)

Fluid Physics

Refer also to abstract 41766.

42022 (DEMO-69/2) SYSTEM ANALYSIS AND SIMULATION IN MAGNETOHYDRODYNAMICS. Kontos, J. (Democritus Nuclear Research Center, Athens (Greece)). May 1969. 60p. Dep.

Engineering system analysis and simulation methods are applied to problems in magnetohydrodynamics. These methods are used for description, analysis, and computation. The main areas in MHD to which the present approach could be applied are reviewed. It is shown how the behavior of vacuum–plasma interfaces can be visualized in terms of field impedances, equivalent networks, and closed-loop systems. Next, these general ideas are applied to some particular cases with infinite conductivity. Two cases with finite conductivity are considered and analog computation is used for their solution. Some attempts to make some progress with a nonlinear case are described briefly. Conclusions and suggestions for further work are given. (M.H.R.)

42023 THE SUPERPOSITION OF FORCELESS AND FORCE MAGNETIC FIELDS IN MAGNETIC HYDRODYNAMICS (POTENTIAL FLOW). Rubo, H. A. Visn. Kiev. Univ., Ser. Astron., No. 8, 11-14(1967). (In Russian).

The possibility is investigated of representing the magnetic field of a conductive fluid (in the general case appearing as the sum of the toroidal and poloidal fields) in the form of a superposition of forceless and force magnetic fields. The axially symmetric potential flow of an infinitely conducting fluid at a given character of motion in the presence of a magnetic field is investigated. The conditions previously obtained by the author (Visn. Kiev. Univ., Ser. Astron., No. 7, (1965)) are superimposed on the magnetic fields to realize the given flow character of the conducting fluid. It is shown that for a class of potential axially symmetric flows of an ideal and viscous conductive fluid, the overall magnetic field cannot be represented in the form of a superposition of forceless and force magnetic fields. (ATD)

42024 BOUNDARY-LAYER TRANSITION. Bakhshi, Vidya Sagar. Corvallis, Oreg., Oregon State Univ., 1969. 119p. Thesis.

An attempt is made to study the laminar boundary-layer transition as an asymptotic phenomenon from the boundary layer. By making an order-of-magnitude analysis, the boundary-layer thickness for two-dimensional flow is estimated in terms of two parameters. One of these parameters depends upon the relative order of magnitude of the viscous and inertia forces at the outer edge of the boundary layer and the other depends upon the order of vorticity allowable at the outer edge of the boundary layer. The transition phenomenon in boundary flow is treated as an asymptotic phenomenon from the boundary layer. In order to study the transition region, a limiting form of the Navier–Stokes equations in three dimensions is obtained, which is called the transition equation. Owing to the importance of vorticity in the transition region, the transition equation is solved for the vorticity. The form of vorticity shows that in general the functions which govern the transition region are either subharmonic or superharmonic functions. In classical two-dimensional flow, the study of cylindrical vortex is made by employing matching techniques. There does not exist any mathematical treatment of the spiral formation which exists in case of flow past a body at large Reynolds number. In this study, two-dimensional flow past a body at large Reynolds number is undertaken on the basis of transition analysis, thus obtaining a satisfactory mathematical treatment of various phenomena that occur in the boundary layer flow. The transition equations for axisymmetric and two-dimensional flow are also obtained. Besides other known results, the transition equation in two dimensions gives the stagnation points and the formation of spirals which is noticed in the flow of a real fluid past any body at large Reynolds number. The transition equation also gives the formation of cylindrical vortices. These vortices are given by the limiting form of the stream function and come out from the transition equation itself without the use of any matching process. Hence, it can be concluded that the transition equation is a global representation of different phenomena which exist in fluid flow past a body at large Reynolds number. The transition concept is also extended to magnetohydrodynamics. A formula for the magnetohydrodynamic boundary layer thickness is obtained in terms of two parameters on the basis of a magnitude analysis. The transition equation for two-dimensional magnetohydrodynamic case is also obtained, and its solution gives the spiral formations. (TSS) (Diss. Abstr.)

42025 DETERMINATION OF FLOWS BEHIND UNSTEADY MAGNETOGASDYNAMIC SHOCK WAVES. Ram, Rishi (Univ. of Allahabad, India). Tensor, 18: 323-9(1967).

The author and others have previously studied various aspects of flows behind stationary and pseudo-stationary shocks. The object of this paper is to determine completely the flow behind an unsteady MGD shock. This is accomplished by determining the gradients of flow and field parameters and obtaining expressions for the curvature and torsion of streamlines behind unsteady shock waves in conducting gases. The condition for existence and uniqueness of flows behind the shock is obtained by applying the Cauchy–Kowaleski theorem directly to the basic equations of motion without transforming them into normal forms. (L.M.T.)

42026 DECAY OF MAGNETOFLUIDDYNAMIC TURBULENCE IN THE PRESENCE OF A UNIFORM IMPOSED MAGNETIC FIELD. Paul, Yash (Indian Inst. of Tech., New Delhi). Tensor, 18: 212-16(1967).

This study discusses how the law of decay of homogeneous magnetoturbulence is modified by the introduction of an external magnetic field. A two-point analysis of the turbulent field is carried out in the manner of Deissler (Phys. Fluids, 6: 1250-9(1963)). Triple correlations are neglected in order to make the problem determinate. Deissler includes Hall currents in the beginning but later on neglects them and solves an initial-value problem. Hall currents are not neglected here, however, and the problem is solved in the manner of Lehnert (Quart. Appl. Math., 12: 321-41 (1955)) who considers the effects of a superimposed solid-body rotation and Coriolis force and obtains the normal modes of decay. (TSS)

42027 VISCOUS MAGNETOHYDRODYNAMIC FLOWS. Sonju, Otto Kristian. Stanford, Calif., Stanford Univ., 1968. 155p. Thesis.

The effects in both fully developed, two-dimensional flows and boundary-layer flows of an applied transverse magnetic field and an applied parallel electric field (i.e., normal to both the flow and the magnetic field) on the dynamic behavior of electrically conducting fluids are investigated. The importance of fluid-property variations, in particular electrical conductivity, in the plasma is studied. Both laminar and turbulent flows are discussed, and experimental as well as theoretical work have been performed. (Diss. Abstr.)

42028 WEAK DISCONTINUITIES IN MAGNETOGASDYNAMICS IN THE PRESENCE OF DISSIPATIVE MECHANISMS. Nariboli, G. A.; Secrest, B. G. (Univ. of Bombay. Univ. of Nebraska, Lincoln). Tensor, 18: 22-5(1967).

The effects of thermal and electrical conductivities on the growth of a weak discontinuity in inviscid magnetogasdynamics are studied. Related problems of blast waves, Burger's MHD equation, and comparative study of the variation of the gradients of field variables across a shock are also briefly considered. The work presented here has a close bearing on the gas-ionizing shocks studied by Kulikovsky and Lyubimov. (TSS)

42029 THERMAL RADIATION AND MAGNETIC FIELD EFFECTS ON THE FLOW VARIABLES NEAR A STAGNATION POINT. Schmidt, Wendelin. East Lansing, Mich., Michigan State Univ., 1968. 121p. Thesis.

Equations connecting the flow variables with the geometric parameters of the streamlines in three-dimensional, inviscid, and viscous radiation MHD gas flow were derived. A simplified mathematical model governing the flow variables distribution near a stagnation point in radiation MHD flow was developed and used to estimate the combined effects of various physical phenomena on the flow field variables. Specifically, the combined effects of thermal radiation, magnetic field, viscosity, heat conductivity and compressibility on the temperature, pressure, electron density, and electric conductivity distribution near a stagnation point were considered. The first-order results obtained from the numerical solutions of the governing equations indicated that the effects of thermal radiation, magnetic field, and compressibility on the flow field variables are considerable, whereas the effects of viscosity and heat conductivity were found to be very small in the case under consideration here. (Diss. Abstr.)

42030 CROSSED-FIELDS MAGNETOGASDYNAMIC FLOWS OVER CONDUCTING BODIES. Lalas, Demetrius Panayiotis. Ithaca, N. Y., Cornell Univ., 1968. 60p. Thesis.

The effect of a conducting body in crossed-field MGD flow is studied. This study can be helpful in understanding the induction drag mechanism for large satellites and the waves that are excited by bodies in the ionosphere. Although infinite conducting bodies are found to have no effect on the flow field, flows along infinite conducting bodies are studied to establish the electromagnetic effects of the current in the body and the flow. Then, compressible MGD flow over three-dimensional bodies is investigated. A Fourier transform technique is used to synthesize the flow over small and large aspect-ratio slender bodies. The small aspect-ratio body is found to affect the flow mainly by inducing current perturbations, diffusive in nature, that overshadow the usual perturbations excited by the body gradients. An anisotropic propagation pattern for the current becomes evident, which carries over to the large aspect-ratio case. For the large aspect-ratio body, two Alfvén waves are excited with disturbances that virtually end at the wingtips. The nonzero conductivity of the body is of no consequence to first order in this case. The effects of the Hall conductivity were also analyzed by use of the same Fourier transform technique. The Hall conductivity does not affect the flow over a small aspect-ratio body. In a flow over a large aspect-ratio body, the Hall conductivity excites current loops that close at finite distances from the body. In this instance, the magnitude of the velocity and current perturbations decay algebraically, not exponentially, as previously reported. (Diss. Abstr.)

42031 LAMINAR MAGNETOHYDRODYNAMIC CHANNEL FLOW WITH WEAK INTERACTION. Hsia, Edward Shu-jen. Cincinnati, Univ. of Cincinnati, 1968. 205p. Thesis.

The weakly interacting MHD entrance flow of an incompressible electrically conducting fluid in a two-dimensional constant-area channel is investigated by the usual integral method. It is assumed that a uniform magnetic field is applied transversely to the flow field and an electric field, applied perpendicularly to both the magnetic field and mean flow, is permitted. The magnetic Reynolds number, assumed vanishingly small in most of the previous studies, is assumed to be of the order of one in the present study so that the variation of the magnetic field can be investigated. Particular emphasis is placed on the effects of wall electric conductivity to the flow field; this problem has not been reported previously for considering the flow development in the entrance region as influenced by the wall conductance. The weakly interacting boundary-layer equations in the MHD channel entrance region were solved by the integral method and the associated iterative procedures. Numerical calculations were performed on the GE-265 digital computer and covered the following ranges: Hartmann number 0 to 10, Reynolds number 100, magnetic Reynolds number 1 to 10, and Prandtl number 0.01 to 100. Solutions derived from the integral method are presented in graphical form. The growth behavior of velocity and magnetic and temperature profiles in an MHD channel entrance were also obtained. (Diss. Abstr.)

42032 MAGNETOHYDRODYNAMIC FLOW BETWEEN TWO NONCONDUCTING COAXIAL CYLINDERS INDUCED BY DEFORMING THE WALLS OF THE CONTAINER. Bhat, P. K. (Indian Inst. of Science, Bangalore). Proc. Indian Acad. Sci., Sect. A, 69: 265-78(May 1969).

The steady axisymmetric flow of a viscous conducting incompressible fluid induced by deforming a cylindrical container in the presence of a nonuniform azimuthal magnetic field is discussed. This field can be realized by passing a current of density J_0 through the axis of the annulus and a current of density J through the conducting fluid. At time $t = 0$ the fluid is supposed to be at rest in the space between two coaxial nonconducting cylinders. Thereafter a small amplitude sinusoidal deformation, which remains constant for the time $t > 0$, is applied to the walls of the tube producing fluid motion. The flow phenomena are discussed for disturbances of small wave number in the steady state reached when the steady electromagnetic forces balance the steady viscous forces. The flow pattern for an inviscid incompressible fluid which is initially streaming along the z-direction with a constant velocity is presented. In both cases the physical parameters were expanded in powers of the wave number k, and these expansions were evaluated up to the third power of k. The flow is discussed in each case for the following wall deformations: both walls deformed, outer wall deformed, and inner wall deformed. In these calculations the conductivity remains arbitrary and the wave number k is assumed to be small. (M.H.R.)

42033 SLOWING OF PLASMA CLUSTERS IN INHOMOGENEOUS MAGNETIC FIELD. Kashkin, Yu. F. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 138-42(May-June 1969). (In Russian).

Magnetohydrodynamic channels with Reynolds magnetic number $R_m \geq 1$ and inhomogeneous magnetic fields along the axis of the channels were studied in order to determine the end effects taking place at the entrance and exit from the magnetic field. The experiments used an electric discharge tube. It was found that the interactions between the end current and magnetic fields resulted in slowing down of the current flow in the channel. It was suggested that a series of plates installed at the field entrance will prevent the high velocity losses by reducing the end-current effects though they would also cause some losses in the gas dynamics. (R.V.J.)

42034 BOUNDARY LAYER OF TWO-TEMPERATURE PLASMA ON ELECTRODES OF MHD CHANNEL WITH CROSSED ELECTRIC AND MAGNETIC FIELDS AT LARGE HALL'S PARAMETERS. Kalikhman, L. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 40-6(May-June 1969). (In Russian).

A system of equations was obtained for boundary layer pinched by magnetized two-temperature plasma on electrodes. Equations were developed for a general case of interface layer of completely ionized quasi-neutral plasma at small Reynolds magnetic number. (R.V.J.)

42035 AN ANALYTICAL INVESTIGATION OF THE STEADY-STATE ONE-DIMENSIONAL MHD SHOCK WAVE STRUCTURE USING CONTINUUM FLUID THEORY. Wong, Wilford Fu. Knoxville, Tenn., Univ. of Tennessee, 1968. 162p.
Thesis.

The structure of a one-dimensional magnetohydrodynamic (MHD) shock wave is investigated using continuum fluid theory with Maxwell's electromagnetic field equations and considering all dissipative mechanisms (viscosity, thermal conduction, and electrical conductivity) to be finite for a fully ionized gas. Shock profiles are presented to show the effects of velocity, magnetic field, electrical conductivity, and the current inertia terms in the generalized Ohm's law. The equations are analyzed by the method of phase space analysis. Conditions are defined for the simultaneous solution of three variables in phase space. In one special case, four variables are solved simultaneously in phase space. All numerical solutions were obtained with an IBM 360 computer. The results of this study show the current inertia terms primarily affect the charge density and electric field profiles. A dimensionless parameter is defined which measures the relative importance of the current inertia terms in the shock problem. The significance of this parameter in macroscopic MHD problem is also discussed. For high magnetic field or velocity, the shock profiles approach the corresponding infinite electrical conductivity case. Because of the higher transport properties for an ionized gas, the MHD shock tends to be more diffuse (thicker) than the ordinary gasdynamic shock profile. (Diss. Abstr.)

42036 MAGNETIC FLUID DYNAMICS. Curtis, Richard Allen. Ithaca, N. Y., Cornell Univ., 1968. 116p.
Thesis.

The dynamic behavior of magnetically polarizable fluids is considered. A summary of the considerations establishing the governing equations for a continuum magnetic fluid is presented, including: a justification for the continuum approximation, the conservation equations, and the equation of state. A series of examples demonstrating characteristic magnetic fluid behavior are then presented. First, the effect of a thin obstacle on the pressure distribution in small disturbance magnetic fluid flow is calculated. Next, it is shown that a low frequency wave disturbance does not propagate in the fluid but is damped out within a skin-depth determined mainly by the heat capacity and thermal conductivity of the fluid. The behavior of magnetic fluids at a free surface is then examined. In particular, the free surface wave behavior is considered when a magnetic field gradient normal to the undisturbed free surface is present. It is concluded that, for an initially level free surface, the velocity of free surface waves is given by the same expression as that for such waves in ordinary fluids except that the gravitational acceleration which appears in the usual expression is now replaced by an effective "gravity" which contains a term proportional to the gradient of magnetic field normal to the undisturbed free surface. Next, the behavior of a magnetic fluid confined between parallel plates is considered in the presence of magnetic and thermal gradients. It is predicted that the fluid will display a convective instability which sets in when the value of a dimensionless number (an equivalent Rayleigh number) exceeds a certain critical value. Finally, the behavior of a nagnetic fluid in the presence of a travelling electromagnetic wave is considered. A resonance arising from the mechanical rotation of the individual magnetic particles of the fluid is noted, although viscous damping will lead to a low value of Q for this resonance. (Diss. Abstr.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 41105 and 41851.

42037 (JINR-P9-4498) INVESTIGATION OF THE SCREENED EARTH MAGNETIC FIELD BY USING THE INDUCTOR PERMALLOY CORE OF THE LINEAR INDUCTION ACCELERATOR. Antsupov, P. S.; Matora, I. M.; Merkulov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 10p. (In Russian). Dep.

The measurement results of the residual geomagnetic field in the neighbourhood of the linear induction accelerator axis are presented. (auth)

42038 WHISTLER DISPERSION AND AMPLIFICATION IN THE MAGNETOSPHERE. Liemohn, H. B. (Univ. of Washington, Seattle). Trend Eng. Univ. Wash., 21: 3-7(Apr. 1969).

The properties of whistler propagation and their use in remote sensing in the magnetosphere are reviewed. Whistler theory is sufficiently well established that the signals can now serve as natural probes for remote sensing of magnetospheric plasma parameters. Both vlf and ulf signals exhibit characteristic dispersion patterns that are explainable by geomagnetic field-line propagation from one hemisphere to the other. Dispersion analysis of large collections of experimental data has provided information about the distribution of thermal plasma in a major portion of the magnetosphere. These electromagnetic signals also exchange energy with the nonthermal plasma through the cyclotron-resonance instability. This interaction relates vlf and ulf power spectra to the pitch angle and energy distributions of energetic electrons and protons. An experimental method for testing and using this interaction in future research programs is discussed. The verification of the cyclotron resonance theory would initiate a new era in remote sensing of the magnetosphere. In addition to their current value as probes of the thermal plasma, whistlers could monitor the energetic particle distributions. (BBB)

42039 EFFECT ON THE LOWER IONOSPHERE OF X RAYS FROM SCORPIUS XR-1. Ananthakrishnan, S.; Ramanathan, K. R. (Physical Research Lab., Ahmedabad, India). Nature (London), 223: 488-9(Aug. 2, 1969).

In recordings of the field strengths of 164-kHz radio waves transmitted from Tashkent a pronounced minimum recurred every night during April to July, the local time of which shifted to earlier hours as the days advanced. It was suggested that the cause might be increased ionization in the lower D region below the reflection level, due to a celestial x-ray source, and further examination showed that the time of the minimum nearly coincided with the transit of Sco XR-1 across 71°E, which is the one-hop reflection meridian of radio waves from Tashkent to Ahmedabad. It was known that Sco XR-1 is the strongest x-ray source in the northern hemisphere near 32°N. (UK)

42040 SATELLITE MEASUREMENT OF UPPER ATMOSPHERIC MOLECULAR OXYGEN DENSITIES. Lockey, G. W. A. (Univ. of Adelaide); Horton, B. H.; Rofe, B. Nature (London), 223: 387-8(July 26, 1969).

Included in the experiments carried by the satellite 1967-118A, WRESAT, launched from Woomera on Nov. 29, 1967, into a nearly polar orbit, were two sets of vacuum-uv sensitive ion chambers designed to determine the density of molecular oxygen in the mesosphere and lower thermosphere by measuring the absorption of solar radiation by the atmosphere as the vehicle passed through satellite sunrise and sunset. The main feature of analyses of the data by the authors is a shelf of almost constant density at altitudes of about 110 to 120 km. A plot is given of O_2 number density against altitude. (UK)

42041 PROGRESS IN IONOSPHERIC RADIO. Villard, O. G. Jr. (ed.) (Stanford Univ., Calif.). Radio Sci., 4: 603-22(July 1969).

Topics covered in this three-year progress report include D-region morphology, D-region theory, F-region morphology, F-region theory, ionospheric dynamics and drift, electron and ion temperature profiles below the F2 peak, radio aurorae, scintillation, hf propagation, vlf propagation, and temperate and equatorial sporadic E. 262 references. (W.D.M.)

42042 PROGRESS IN MAGNETOSPHERIC RADIO. Fejer, J. A. (ed.) (Univ. of California, San Diego, La Jolla). Radio Sci., 4: 622-34(July 1969).

Topics covered in this three-year progress review include the magnetosphere and the magnetotail, plasmapause, whistlers and ion effects, wave-particle interactions, vlf emissions, electrostatic waves, hydromagnetic disturbances, incoherent backscatter, topside resonances, plasma composition and temperature above the F2 peak, and ion composition and diffusion above the F2 peak. 192 references. (W.D.M.)

42043 DRIFT WAVE INSTABILITY ON THE PLASMAPAUSE WITH A SLIGHT MODIFICATION DUE TO THE VELOCITY SHEAR. Okuzawa, Takashi (Tokyo Univ.). Inst. Space Aeronaut. Sci., Univ. Tokyo, Rep., 34: 15-36(Feb. 1969).

Drift-wave instabilities in low-β plasma due to the gradient in particle number density, which are likely to exist in the plasmapause, are discussed with consideration of a slight modification due to the velocity shear. By use of a simple model in configuration space, the growth rate of the low-frequency universal drift mode and of the drift cyclotron resonance mode are calculated in modified forms through the Vlasov equation. The treatment is confined to the electrostatic modes. The applicability of the results to the actual plasmapause is discussed. The dusk meridian region was examined in particular. The possibility is suggested that these instabilities are slightly enhanced in that region. (BBB)

42044 ELECTROMAGNETIC TRANSMISSION PROPERTIES OF A MODEL IONOSPHERE IN THE FREQUENCY RANGE 0.001 TO 0.1 Hz. Bielecki, Anthony John. Fort Worth, Tex., Texas Christian Univ., 1968. 131p.

Thesis.

An attempt is made to determine the effect of the ionosphere upon the character of the power spectra of measured terrestrial magnetic field variations in the micropulsation region of the electromagnetic spectrum. A theoretical model of the Earth's ionosphere is developed for situations approximating the physical conditions at mid-geomagnetic latitudes. The model is constructed so that it is possible to compute the electromagnetic transmission properties in the frequency range .001 to .1 Hz. Two models are taken to represent daytime and nighttime conditions during minimum sunspot activity. The results show that varying the angle of incidence up to 60° from normal produces effects which are small in comparison to the effects from other causes. On the basis of the models chosen, the ionosphere can be considered transparent during the nighttime. During the daytime, the transmission character depends upon the type of wave mode propagating. In general, the effects are moderate compared to the dynamic character of observed power spectra of terrestrial geomagnetic fields. It is concluded that the ionosphere below 2000 km does not significantly contribute to the character of observed terrestrial geomagnetic power spectra. (Diss. Abstr.) (TSS)

42045 IONOSPHERIC OBSERVATION OF VLF ELECTROSTATIC NOISE RELATED TO HARMONICS OF THE PROTON GYROFREQUENCY. Mosier, S. R.; Gurnett, D. A. (Univ. of Iowa, Iowa City). Nature (London), 223: 605-6(Aug. 9, 1969).

This type of noise was observed with the Javelin 8.46 sounding rocket launched from Fort Churchill, Canada, at 0518:48UT on May 25, 1968. The rocket carried a vlf electric- and magnetic-field experiment including eight antennas and six receivers and an electrostatic analyzer for the measurement of electron and proton fluxes in the energy range 5 to 50,000 eV. Wide-band data from the x-axis electric receiver are shown in the form of a frequency-time spectrogram from 262 to 290 sec after launch; noise bands occurred from 271.5 to 274.2 sec and again from 279.8 to 281.6 sec after launch. Upper and lower cutoff frequencies are also shown, together with the corresponding proton gyrofrequency harmonics. These harmonics were generally within the attenuation bands of the observed emission. The noise intensities from the long and short electric antennas were very nearly equal, strongly suggesting that the wavelength of the observed noise was short compared with the antenna length (3.16 m). This wavelength was consistent with the characteristic length expected for gyrofrequency interactions. No comparable noise was observed with the magnetic loop antennas. The effects observed at harmonics of the proton gyrofrequency are believed to be the first confirmed observation of ion gyrofrequency harmonic effects in the ionosphere. (UK)

42046 DAILY VARIATION OF THE GEOMAGNETIC FIELD AND THE DEFORMATION OF THE MAGNETOSPHERE. Sarabhai, V.; Nair, K. N. (Physical Research Lab., Ahmedabad, India). Nature (London), 223: 603-5(Aug. 9, 1969).

At low latitudes the horizontal component of the geomagnetic field shows a maximum around local noon and a minimum between 1800 and 0600 hr local time, and the range of the daily variation ΔH is strikingly enhanced in the region ±3° geomagnetic latitude due to the electrojet current in the E region. The present authors were interested in verifying whether, at a low-latitude station outside the influence of the electrojet, ΔH represents an increase on the day side over a base level at H_{min} or a decrease on the night side from a base level at H_{max}. In the former case there should be a positive correlation between ΔH and H_{max}, with poor correlation between ΔH and H_{min}, while in the latter case there should be a negative correlation between ΔH and H_{min} and a poor correlation between ΔH and H_{max}. Data from the geomagnetic observatory at Alibag (geomagnetic latitude 9°30′N) indicated a good negative correlation between ΔH and H_{min}, with a poor correlation between ΔH and H_{max}. These characteristics applied to all years of the solar cycle 1954 to 1964. It was concluded that ΔH at a low-latitude station outside the effect of the electrojet is due to a decrease of the ambient field on the night side rather than an increase during the daytime. Even at the geomagnetic equator, at a distance of 6.6 R_E, where the effect of the electrojet in the E region is negligible, satellite data have demonstrated that the daily variation on an average day corresponds to a decrease of about 30 to 40 gammas along the antisolar direction compared with the subsolar direction. Also, the degree of geomagnetic disturbance on individual days does not appreciably alter the relationship between ΔH and H_{min}. Since E-region currents would be largely absent on the night side, it is suggested that the observed effect is connected with the convective drift currents in the magnetosphere within the pseudo-trapping region and the asymmetric part of the ring currents in the stable trapping region. Drift currents in the stable trapping region would influence H_{max} as well as the daily mean value of H. It is stated that the experimental evidence presented indicates that the effects of ring currents can be measured on the surface of the Earth at low-latitude stations on almost all days, and that these dominate over the ionospheric dynamic currents. The Earth can also be used as a plasma probe in the solar wind. (UK)

42047 EFFECT OF SHELL SPLITTING ON RADIAL DIFFUSION IN THE MAGNETOSPHERE. Roederer, Juan G. (Univ. of Denver); Schulz, Michael. J. Geophys. Res., 74: 4117-22(Aug. 1, 1969).

The radial diffusion coefficient D_L attributable to pitch-angle scattering in the presence of magnetic shell splitting is calculated analytically to lowest order in μ_0 and L, where μ_0 is the cosine of the equatorial pitch angle at the midnight meridian and L is the McIlwain parameter. The result is that $D_L \sim R_s^{-8} L^{10} (\mu_0^2/\tau)$, where R_s is the stand-off distance to the magnetopause (in earth radii) and τ is the lifetime against pitch-angle scattering. For electrons (E > 0.5 MeV) having $\mu_0 \lesssim 0.5$ this diffusion coefficient falls an order of magnitude below the coefficient of diffusion that is customarily extracted from observational data under the assumption that the first two adiabatic invariants are conserved. (auth)

42048 MEASUREMENT AND INTERPRETATION OF POWER SPECTRUMS OF IONOSPHERIC SCINTILLATION AT A SUBAURORAL LOCATION. Elkins, Terence J. (Air Force Cambridge Research Labs., Bedford, Mass.); Papagiannis, Michael D. J. Geophys. Res., 74: 4105-15(Aug. 1, 1969).

A study of the power density spectrum of ionospheric scintillation of a radio star and satellites, at a subauroral location, has revealed the following: (1) Scintillations generally display a "pink" noise spectrum, with almost uniform spectral density at frequencies below ~ 0.01 Hz, and decreasing spectral density at frequencies above this value. (2) At frequencies $f \gtrsim 0.01$ Hz, the power spectrum varies as f^{-n}, with n being typically 2.7 (i.e., a decrease of 8 db per octave). (3) The width of the spectrum displays a diurnal variation such that, on the average, higher scintillation frequencies are observed at night than during the day. These results have been examined in the context of existing theories involving electrodynamic or hydromagnetic processes, in an attempt to establish the source of the ionospheric irregularities. Although many theories suggest that hydromagnetic waves are responsible for the observed irregularities, they leave the precise nature of the interaction in doubt. It is noted that the spectrum of geomagnetic micropulsations is in substantial agreement with the scintillation power spectrum, and, therefore, a theory is developed tying the two phenomena together. A model is proposed in which horizontally ducted hydromagnetic waves produce irregularities in the F region and geomagnetic micropulsations, causing both to have the same power law spectrum. (auth)

42049 WIND-DRIVEN INSTABILITY IN THE LOWER E REGION. Chimonas, G. (Univ. of Toronto). J. Geophys. Res., 74: 4091-8(Aug. 1, 1969).

A field-aligned instability, which arises when neutral winds drive ionization across a magnetic field, is examined under the conditions that hold in the lower E region. It is found that predicted growth rates are sufficiently high to make small-scale modulations of any strong ionization gradients found in this region a common occurrence. (auth)

42050 EDDY DIFFUSION COEFFICIENTS DUE TO INSTABILITIES IN INTERNAL GRAVITY WAVES. Hodges, R. R. Jr. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 74: 4087-90(Aug. 1, 1969).

Internal gravity waves in the upper atmosphere tend to grow in amplitude with increasing height to maintain continuous vertical transport of wave energy. The growth of amplitude of a wave is limited by convective instabilities that must form at the height where the temperature oscillation becomes great enough to include a superadiabatic region. This turbulence attenuates the wave by eddy transport of heat and viscous stress through the wave structure, essentially maintaining a constant amplitude of the wave at greater altitudes. Eddy diffusion coefficients of the order of 10^7 cm^2/sec are readily produced by typical gravity waves near the mesopause. Since an average coefficient of only 10^6 cm^2/sec is sufficient to explain the thermal structure of the mesopause region, sporadic turbulence produced by instabilities in gravity waves is probably an important process of the upper atmosphere. (auth)

42051 PREDISSOCIATION IN THE SCHUMANN–RUNGE BAND SYSTEM OF O_2: LABORATORY MEASUREMENTS AND ATMOSPHERIC EFFECTS. Hudson, R. D.; Carter, V. L.; Breig, E. L. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res., 74: 4079-86(Aug. 1, 1969).

Recent measurements on the Schumann–Runge system of molecular oxygen indicate that the vibrational levels of the B $^3\Sigma_u^-$ state above $v' = 2$ are subject to predissociation. This paper describes a laboratory determination of the rate of dissociation of molecular oxygen resulting from absorption in the Schumann–Runge bands and presents the results of calculations of the effect of this additional source of oxygen atoms on the chemistry of the lower thermosphere and the upper mesosphere. It is shown that significant increases in the atomic oxygen and ozone concentrations can result from this absorption at altitudes around 80 km. (auth)

42052 TEMPERATURE SHAPE PARAMETER OF THE THERMOSPHERE DETERMINED FROM PROBE DATA. Swenson, Gary R. (Marshall Space Flight Center, Huntsville, Ala.). J. Geophys. Res., 74: 4074-8(Aug. 1, 1969).

The static diffusion model of the upper atmosphere developed by Jacchia in 1965 uses an exospheric temperature dependence to arrive at a temperature shape parameter that is used to generate the thermospheric temperature profile. Contained here is the analysis of shape parameters deduced from eighteen thermosphere probe flights. Findings show a dependence of the shape parameter on the hour angle, indicating the thermospheric temperature profile to be more dependent upon the dynamics of heating and cooling than on the exospheric temperature. (auth)

42053 DIURNAL AND SEASONAL VARIATION OF ATMOSPHERIC ION COMPOSITION; CORRELATION WITH SOLAR ZENITH ANGLE. Brinton, H. C.; Pickett, R. A.; Taylor, H. A. Jr. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 4064-73(Aug. 1, 1969).

A global measurement of the diurnal and seasonal variations of the primary atmospheric ions in the topside ionosphere between 280 and 2700 km has been made using the ion mass spectrometer on Explorer 32. Evidence of direct correlation between solar zenith angle and the low and midlatitude distributions of thermal O^+, N^+, He^+, and H^+ was obtained as the satellite orbit plane traversed one complete diurnal cycle between June 11 and October 5, 1966. The northern midlatitude ionosphere at 1600 km, near the O^+–H^+ transition level, exhibited strong diurnal variation, O^+ rising sharply at dawn to become the dominant daytime ion with a concentration of 1×10^4 $ions/cm^3$; H^+ was dominant at night with a concentration of 1×10^4 $ions/cm^3$, a factor of 5 higher than its daytime value. The diurnal variations of N^+ and He^+ in this region resembled those of O^+ and H^+, respectively, at reduced concentrations. Measurements at 1200 km in the geomagnetic latitude intervals 45° to 55° (summer hemisphere) and −45° to −55° (winter hemisphere) showed a strong seasonal change in the O^+ and N^+ diurnal distributions, but little change in H^+ and He^+. In summer the O^+ concentration increased to 2×10^4 $ions/cm^3$ by 0600 LT; this daytime level was maintained until dusk at 1900 LT. The winter O^+, however, was maintained at this daytime level only between 1100 and 1600 LT. The N^+ distributions paralleled those of O^+, the O^+/N^+ ratio being about 10. It is found, at least for midlatitudes, that the observed diurnal and seasonal variation of O^+ scale height between 1000 and 1500 km is directly related to the variation of solar zenith angle. Less pronounced diurnal variations are observed at the midlatitude F maximum and in the low-latitude protonosphere. (auth)

42054 MASS SPECTROMETRIC INVESTIGATION OF THE THERMOSPHERE AT HIGH LATITUDES. von Zahn, U.; Gross, J. (Univ., Bonn). J. Geophys. Res., 74: 4055-63(Aug. 1, 1969).

The number densities for N_2, O_2, O, and Ar in the 115 to 155 km range were measured by means of a monopole spectrometer flown aboard a Black Brant 3 rocket launched at the Churchill Research Range on December 12, 1966, at 1320 CST. The N_2 density at 150-km altitude was found to be higher by a factor of 1.3 than the average of mass spectrometric determinations performed at temperate latitudes during the years 1966 and 1967. A low Ar content and a high He content (the latter measured by a mass filter aboard the same rocket) both point toward an altitude of the turbopause below 100 km. Unexpected high O_2 densities in the ion source could only be explained by a considerable degree of recombination of O to O_2 at the ion source walls. Similar to the ESRO CO7 flight, but less pronounced, a wave-like structure was found superimposed on the density profiles of all constituents. Neutral-gas temperatures did not significantly deviate from the CIRA 1965 values. (auth)

42055 A STUDY OF POLAR MAGNETIC SUBSTORMS. 2. THREE-DIMENSIONAL CURRENT SYSTEM. Meng, C.-I.; Akasofu, S.-I. (Univ. of Alaska, College). J. Geophys. Res., 74: 4035-53(Aug. 1, 1969).

Three-dimensional current systems are constructed semi-quantitatively for different epochs of several polar magnetic substorms, mainly on the basis of the distribution of their magnetic fields on the Earth's surface. In a representative case the current system consists of an asymmetric ring current belt in the day–evening sector, current along the field lines from the morning end of the ring current to the northern and southern ionospheres, ionospheric current along the auroral oval in the dark sector (the auroral electrojet), and current along the field lines from the western end of the auroral electrojet to the ring current. The distribution of asymmetric ring current particles thus deduced in a previous paper (Akasofu and Meng, 1969) and in this work is remarkably similar to that observed by Frank (1968). (auth)

42056 IMPROVED MODEL EQUATORIAL ELECTROJET WITH A MERIDIONAL CURRENT SYSTEM. Sugiura, M. (Goddard Space Flight Center, Greenbelt, Md.); Poros, D. J. J. Geophys. Res., 74: 4025-34(Aug. 1, 1969).

The σ_{yy} model for the equatorial electrojet presented earlier is revised by including a meridional current system, thus making the current density divergence-free. Using a spherical harmonic expansion for the geomagnetic field, a model electrojet is constructed for each of the longitudes of 0°, 40°, 80°, 180°, and 280°E. It is shown that the essential feature of the meridional current system is the existence of two current loops, one on each side of the dip equator and with an equatorward current in the lower E region, an upward current over the dip equator, and a return current flowing in the upper E region. The intensities of the electrojet and the associated meridional current are significantly dependent on longitude, being strongest over Peru and weakest over India. The new model predicts a reversed (westward) current in a thin, narrow layer located at several degrees off the dip equator, which is due to a reversal of the vertical polarization field. The meridional current loop creates a toroidal magnetic field of an intensity comparable with that of the main electrojet. (auth)

42057 RELATIONSHIP BETWEEN THE FLUX MAGNITUDE AND PITCH-ANGLE DISTRIBUTION FOR POST-SUBSTORM AURORAL ELECTRONS. Reasoner, David L. (Rice Univ., Houston, Tex.). J. Geophys. Res., 74: 4018-24(Aug. 1, 1969).

Measurements of pitch-angle distributions of auroral electrons with energies ranging from a few hundred eV to 60 keV and greater are reported. Electrons with energies of 35 keV or less were always isotropic over the loss cone to within a factor of 2 regardless of flux magnitude, whereas electrons with energies of 60 keV and greater showed a strong functional dependence between the flux magnitude and degree of isotropy. The high-energy electron pitch-angle distribution was strongly anisotropic for flux levels in the trapping region of 10^4 electrons/cm^2 ster sec or less but was isotropic for flux levels of 2.5×10^4 electrons/cm^2 ster sec or greater. Implications of these data with regard to theories or models of particle precipitation or acceleration are considered. (auth)

42058 SIMULTANEOUS OBSERVATIONS OF 5- TO 15-SECOND PERIOD MODULATED ENERGETIC ELECTRON FLUXES AT THE SYNCHRONOUS ALTITUDE AND THE AURORAL ZONE. Parks, G. K.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 74: 4003-17(Aug. 1, 1969).

Two magnetospheric substorm particle events recorded simultaneously at the 6.6 R_E equatorial plane and the conjugate region on Earth in the auroral zone were analyzed for fast temporal structures. The analysis indicated that the 10-second quasi-periodic modulations observed commonly in precipitation events also exist in trapped energetic electron fluxes confined in the equatorial plane. The Fourier spectral analysis showed a significant peak at 7 to 8 second periods for both the trapped and precipitated electron fluxes for the event that occurred on April 21, 1967, whereas the spectral analysis of the August 17 event showed a complicated multipeak frequency spectrum for both regions. The time development characteristics of these modulations were also studied by dynamic spectral analysis method. The coherence analysis of the two sets of data showed that the modulations in the equatorial plane and the auroral zone were generally uncorrelated, with the exception of a 6-minute duration at the beginning of the April 21, 1967, event. Finally, the analysis revealed that although the modulations in precipitated fluxes attained peak-to-valley flux ratios of about 2, the modulations in the equatorial plane were only a few percent. (auth)

42059 TRANSVERSE WAVE PROPAGATION AND INSTABILITIES WITHIN THE MAGNETOSPHERE. Bird, H. H.; Schmidt, G. (Stevens Inst. of Tech., Hoboken, N. J.). Contract AT(30-1)-3785. J. Geophys. Res., 74: 3993-4002(Aug. 1, 1969).

The interaction is studied of transverse waves (propagating parallel to a uniform magnetic field) with the particles described by a double-humped velocity-space distribution function that is loss-cone limited. Such a distribution function can represent the magnetospheric plasma whose energetic secondary hump is observed to be roughly isotropic except for the loss cone. A Nyquist analysis of the dispersion relation shows initially that any plasma that is isotropic except for the loss cone can be unstable to transverse waves. Growth (damping) rates are then obtained in terms of the mirror ratio R and the details of the particle distribution function for each species. These results are then specialized for the case of a double-humped isotropic loss-cone velocity distribution. By treating the thermal component as effectively cold, it is found that the relatively small energetic component of the secondary hump can introduce, if sufficiently monoenergetic, additional instability not otherwise present for monotonic distributions. The actual particle distribution observed within the magnetosphere is then considered, and the results of numerical computations of damping rates are presented. (auth)

42060 VLF ELECTRIC AND MAGNETIC FIELDS OBSERVED IN THE AURORAL ZONE WITH THE JAVELIN 8.46 SOUNDING ROCKET. Gurnett, Donald A.; Mosier, Stephen R. (Univ. of Iowa, Iowa City). J. Geophys. Res., 74: 3979-91(Aug. 1, 1969).

Results of the Javelin 8.46 vlf electric and magnetic fields experiment flown from Fort Churchill, Canada, on May 25, 1968, are discussed. This experiment carried three orthogonal magnetic loop antennas, three orthogonal long (3.16 meters) electric dipoles, two short (42 cm) electric dipoles, and six wideband (30 Hz to 10 kHz) receivers for amplifying signals from the various vlf antennas. Intense noise bursts with frequencies less than about 1.5 kHz were observed on all the electric antennas below 500-km altitude, but not on the loop antennas. The precession and spin modulation of these noise bursts suggest that the noise is generated by an interaction between the payload and the surrounding plasma. High-frequency electrostatic noise bursts, from 5 to 30 kHz, were observed throughout the flight. These noise bursts, similar in some respects to lower-hybrid-resonance noise commonly observed with satellite vlf electric field experiments, also appear to involve an interaction between the payload and the surrounding plasma. Attenuation bands at harmonics of the proton gyrofrequency were also found in the frequency spectra of electric field noise observed during a portion of the flight. (auth)

42061 EVIDENCE OF ELECTROSTATIC PROTON CYCLOTRON HARMONIC WAVES FROM ALOUETTE 2 SATELLITE DATA. Harvey, R. W. (Communications Research Center, Ottawa). J. Geophys. Res., 74: 3969-78(Aug. 1, 1969).

An elf noise band observed by the Alouette 2 receiver was analyzed using digital power spectrum techniques. Detailed spectra indicate that for altitudes 500 to 3000 km and all geomagnetic latitudes sharp lower frequency cutoffs of the noise band occur very near to the calculated proton gyrofrequency. Further spectral characteristics are pointed out. All aspects of the noise band are interpreted in terms of ambient electrostatic proton cyclotron harmonic waves. In particular, this hypothesis explains such features of the noise spectra as the upper and lower cutoffs of the noise band at harmonics of the gyrofrequency and the changing character of cutoffs due to changing accessibility conditions and Doppler shifting. (auth)

42062 OBSERVATION OF INTERPLANETARY FIELD LINES IN THE MAGNETOTAIL. Anderson, K. A.; Lin, R. P. (Univ. of California, Berkeley). J. Geophys. Res., 74: 3953-68(Aug. 1, 1969).

A method of finding the topology of magnetic field lines in the magnetotail using solar electrons as field line tracers is described. The method depends on the presence of a large absorber such as the Moon. Applying this method to spacecraft data one finds: (1) Most of the field lines in the magnetotail at 60 R_E geocentric distance are connected to the interplanetary field. (2) On one occasion, field lines of interplanetary character were found at the center of the magnetotail at a geocentric distance of about 60 R_E. One interpretation of this observation is that the reconnection region must have been at a geocentric distance less than 60 R_E. (auth)

42063 AN ON-BOARD TECHNIQUE FOR ESTIMATING THE EFFECT OF WATER VAPOR IN RADIO OCCULTATION MEASUREMENTS OF ATMOSPHERIC DENSITY. Tank, William G. (Boeing Scientific Research Labs., Seattle). J. Geophys. Res., 74: 4147-56(Aug. 1, 1969).

S-band phase path measured between two earth satellites—one in an occultation orbit relative to the other—determines the integrated radio refractivity of the neutral Earth atmosphere. Atmospheric density is recoverable from such determinations provided an independent estimate of the contribution of water vapor to integrated refractivity is obtained. Transmission measurements in the vicinity of the 22.235-GHz resonant water vapor absorption line provide this estimate. Such data relate to the atmospheric water vapor content integrated precisely over the satellite-to-satellite phase path. The optimum frequency for the transmission measurement is that at which the dependence on line width of the water vapor absorption coefficient is a minimum. The accuracy of the measurement is inversely proportional to the actual atmospheric water vapor content; but a resultant, nearly tenfold increase in the accuracy of the air density data ultimately recovered from the phase path data can be expected for midtropospheric regions. Phase path could be measured at the optimum frequency for the transmission measurement. A single-frequency system could thus provide all the information necessary for the enhanced density data from the occultation experiment. (auth)

42064 CORRELATION OF SUDDEN FREQUENCY DEVIATIONS WITH SOLAR MICROWAVE BURSTS. Basu, S. (University Colleges of Science and Tech., Calcutta); Chowdhury, S. Roy. J. Geophys. Res., 74: 4175-7(Aug. 1, 1969).

The paper presents some investigations on the correlation of sudden frequency deviations (abbreviated as SFD) of hf radio waves propagated through the ionosphere and solar microwave bursts at 606, 2695, and 8800 MHz. It is found that correlation between SFD's and solar radio bursts improves with burst amplitude and frequency. The correlation is 100% at 2695 and 8800 MHz when the burst amplitude is greater than 500×10^{-22} w m^{-2} Hz^{-1}. In addition, it is found that SFD's associated with solar radio bursts having large amplitudes show good correlation with optical flare events. (auth)

42065 LATITUDINAL VARIATIONS IN THE NEUTRAL ATMOSPHERIC DENSITY. Newton, George P.; Pelz, David T. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 74: 4169-74(Aug. 1, 1969).

In situ atmospheric density measurements from the Explorer 32 density gages for the time period May through October 1966 reveal latitudinal density structure in the neutral thermosphere during geomagnetically undisturbed times. For altitudes between 300 and 700 km the summer northern latitude densities are greater than the equatorial densities. For latitudes greater than 55°N, the northern latitude to equatorial latitude density ratio is smallest during the day (near 1.3) and increases at night to values greater than 2. Large (>3) high-latitude to equatorial density ratios are observed near or in the auroral zone. These large ratios are observed even on geomagnetically quiet days. These results suggest that auroral zone and high latitude heating is a permanent feature of the summer thermosphere. (auth)

42066 INTERFEROMETRIC MEASUREMENTS OF THE 6300 A DOPPLER TEMPERATURE DURING A MAGNETIC STORM.

Hays, P. B.; Nagy, A. F.; Roble, R. G. (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 74: 4162-8(Aug. 1, 1969).

The 6300 A Doppler broadened emission line of atomic oxygen [O(^{1}D –O ^{3}P)] was measured with a 6-inch, high resolution Fabry–Perot interferometer during the magnetic storm period of October 30 to November 2, 1968. The Doppler temperatures thus obtained give a realistic indication of the storm-time variation of the exospheric temperature. The measured temperature variation is in general agreement with the model predictions, although the amplitude and phase of the Doppler temperature variation indicate that the exospheric temperature responds more rapidly than the drag results indicate. (auth)

42067 ISOLATED FIELD-ALIGNED IRREGULARITY. Lyon, G. F.; Holbrook, J. A. D. (Univ. of Western Ontario, London). J. Geophys. Res., 74: 4193-5(Aug. 1, 1969).

During a series of measurements of the signal strength of the 20-MHz beacon transmission from satellite 1964–64A many records had to be disregarded because of the presence of amplitude scintillations. Most of the discarded records were of little interest and yielded no new information to add to the well-documented statistics of the scintillation of satellite signals. A few of the scintillating records, however, exhibited regular fading patterns of the type described by Freland and Preddey (1967). The purpose of this note is to discuss in some detail a particular example in which a diffractive pattern appeared centered on the magnetic field line passing through the receiving station. (W.D.M.)

42068 NEUTRAL ATMOSPHERE WAVE GENERATION BY THE EQUATORIAL ELECTROJET. Knudsen, W. C. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res., 74: 4191-2(Aug. 1, 1969).

The concentration of ionospheric current at the equator in the form of the equatorial electrojet and the temporal perturbations thereof may be expected to generate internal gravity waves at low latitude. The purpose of this paper is to estimate the amplitude of the waves relative to that generated in the polar regions. (W.D.M.)

42069 ION SEPARATION IN TEMPERATE ZONE SPORADIC E AND THE LAYER SHAPE. Chimonas, G. (Univ. of Toronto). J. Geophys. Res., 74: 4189-90(Aug. 1, 1969).

It has been shown in a previous paper (Chimonas and Axford, 1968) that below altitudes of 110 km or so the downward phase propagation of wind profiles may cause temperature zone sporadic E layers to be located noticeably above the wind nodes at which they would occur if no propagation took place. In this note it is remarked that when such layers are formed from several species of ions they should have a fine structure of overlapping sublayers, one for each species. (W.D.M.)

42070 TRIGGERING OF HYDROMAGNETIC WHISTLERS BY SFERICS. Fraser-Smith, A. C.; Roxburgh, K. R. (Lockheed Palo Alto Research Lab., Calif.). Planet. Space Sci., 17: 1310-12(June 1969).

It is still not clear what triggers the individual hydromagnetic emission, although there have been many possible mechanisms put forward, such as hydromagnetic noise in the magnetosphere, Cherenkov or cyclotron radiation from high energy particles and the high frequency tail of a transient magnetic variation. This paper presents an argument that certain hydromagnetic emissions can also be triggered by sferics. (auth) (UK)

42071 RADIAL MOTION RESULTING FROM PITCH-ANGLE SCATTERING OF TRAPPED ELECTRONS IN THE DISTORTED GEOMAGNETIC FIELD. Faelthammar, Carl-Gunne; Walt, Martin (Lockheed Palo Alto Research Labs., Calif.). J. Geophys. Res., 74: 4184-6(Aug. 1, 1969).

It is concluded that the radial diffusion produced by pitch-angle scattering in the distorted field cannot be an important source of trapped electrons, although the mechanism undoubtedly occurs. This conclusion is based primarily on the magnitude of the appropriate diffusion coefficient that is found to be much smaller than the observed radial diffusion coefficient. Furthermore, with the existing distribution of trapped electrons in the outer belt, L-shell splitting will cause a net radial transport of particles out of the belt and is thus more of a loss mechanism than a source mechanism. (W.D.M.)

42072 MODEL STUDIES OF LOW-ENERGY PLASMA IN THE OUTER MAGNETOSPHERE. Grebowsky, Joseph Mark. University Park, Penn., Pennsylvania State Univ., 1968. 152p. Thesis.

The motion of low energy plasma in the outer magnetosphere is considered. In particular, theoretical plasma models are set up to describe the motion of plasma along a magnetic field line, as the plasma and the "frozen-in" field follow the convection pattern inherent to the "open" model of the magnetosphere. The component of the electric field parallel to the earth's magnetic field lines plays a significant role in this investigation. At interconnection of the interplanetary and earth field lines on the day side of the earth, two dissimilar plasmas merge. The electrons are considered to rapidly interdiffuse. Due to the small thermal velocities of the low energy protons, however, the protons must be considered in the light of the past history of the parallel electric field. Using model distribution functions the electron density is determined at every point along the open field lines as a function of the local electrostatic potential. A study of the proton motion indicates that a minimum of electrostatic potential may occur near the magnetopause. Therefore, electrons trapped between the potential minimum and the magnetic mirror had to be included in the analysis. Given the proton density at all points along an open field line, the derived density–potential profiles are used to determine the parallel electric field variation along the field line. At reconnection on the night side, proton streams traveling along magnetic field lines away from the earth collide at the equator. It is hypothesized that plasma shocks then form which travel away from the equator, along magnetic flux tubes towards the polar ionospheres as the closed field line formed by reconnection moves towards the day side. The shocks are studied for the simple case in which the ordered proton motion is completely randomized by their passage. (Diss. Abstr.)

42073 INTERPLANETARY FIELD AND GEOMAGNETIC VARIATIONS: A UNIFIED VIEW. Hirshberg, J.; Colburn, D. S. (Ames Research Center, Moffett Field, Calif.). Planet. Space Sci., 17: 1183-1206(June 1969).

The relationship between interplanetary magnetic fields as seen by the Ames magnetometer on board Explorer 33 and surface magnetic variations were studied. The emphasis of the study was toward achieving a unified view of all the experimental results. Various statistical studies of the relationship between K_p and parameters of the solar wind were carried out. The effect of the direction of the z component of the interplanetary field was confirmed. In all other statistical studies the data were divided into two groups, one in which the 3-hr average field pointed northward, and the other in which it pointed southward. In this way it is shown that the tendency toward an association of high K_p with intense interplanetary fields is independent of the north–south effect. The Sun was considerably disturbed during the period covered by this study, giving an excellent opportunity to observe the magnetic configuration of flare-induced interplanetary storms and their relation to geomagnetic storms. The interplanetary storm was found to be typified by persistent strong fields (up to 30 γ) that rose far out of the ecliptic plane. This is to be expected on the basis of simple models. It was also found that high-velocity plasma and intense, highly disturbed interplanetary fields are typical of interplanetary storms. The close association of these parameters in the interplanetary medium is one cause of confusion in interpretations of geomagnetic studies. During the flare-produced storm of February 15, 1967, there was a remarkably close temporal association between events in space and on the surface. This event is discussed in detail. (auth)(UK)

42074 ROCKET STUDIES OF SPORADIC-E IONISATION. Dorling, E. B.; Norman, K.; Willmore, A. P. (University Coll., London). Planet. Space Sci., 17: 1207-11(June 1969).

A combined investigation of sporadic-E ionization was made in two rocket firings at Woomera, South Australia. The results of positive ion density measurements by means of positive ion probes are reported and compared with separate wind shear observations. On the first occasion a sporadic-E-layer was found to occur at 111 km near mid-afternoon, but the wind measurements were not successful. On the second occasion a layer was found at 108 km, where there was a large (60 m/sec) westward component of the wind and a wind shear in the opposite sense to that predicted by the Whitehead–Storey theory. The layer was too high to have been dumped in the way suggested by Chimonas and Axford, (1968). (auth)(UK)

42075 HELIUM EMISSION (1.083 μ) IN SUNLIT AURORA. Harrison, A. W.; Cairns, C. D. (Univ. of Calgary, Alberta, Can.). Planet. Space Sci., 17: 1213-19(June 1969).

The absolute brightness of HeI(1.083 μ) and of OI(5577 Å) was measured in sunlit aurora for different shadow heights of solar 1.083 μ radiation. The results are consistent with current ideas on primary electron precipitation in the atmosphere and excitation of He(2^{3}S) by secondary electrons, and show that simultaneous monitoring of HeI(1.083) and OI(5577) could be used to monitor changes in the primary electron spectrum in sunlit aurora. The HeI(1.083) emission has a brightness of ~15 kR in an IBC II aurora for a fully illuminated atmosphere. (auth)(UK)

42076 TEMPERATURE DEPENDENCE OF THE RATE CONSTANTS FOR THE REACTIONS $O^+ +$ [illegible] $\rightarrow O_2^+ + O$, AND $O^+ + N_2 \rightarrow NO^+ + N$. Stubbe, Peter (Goddard S[illegible]e Flight Center, Greenbelt, Md.). Planet. Space Sci., 17: 1221-31(June 1969).

The dependency of the rate constant k_r for the reactions $O^+ + O_2 \rightarrow O_2^+ + O$ (k_1) and $O^+ + N_2 \rightarrow NO^+ + N$ (k_2) on the gas temperature T, the vibrational temperature T_v of the molecular reactant, and the relative flow velocity v_s between the gases, was studied theoretically by means of a collision theory approach. The resulting expression for k_r contains the two unknown parameters A (activation energy) and P_0 (scaling factor) which have to be determined empirically. $k_1(T)$ was found to have a minimum at about 650°K and a nearly linear increase for temperatures above 750°K. For reaction (2) the rate constant is presented as a function of T and A, since uncertainties in the experimental results do not allow a reliable determination of A. The increase rate of k_2 with $T_v(N_2)$, the vibrational temperature of N_2, falls off strongly with increasing gas temperature. (auth)(UK)

42077 PROCESSES FOR METEORIC ELEMENTS IN THE E REGION. Swider, W. Jr. (Air Force Cambridge Research Lab., Bedford, Mass.). Planet. Space Sci., 17: 1233-46(June 1969).

Ionization and loss mechanisms for meteoric elements are discussed. The relative behavior of the various species is related to information compiled on the relevant bond energies and ionization potentials. It is argued that atomic oxygen prevents the buildup of ionic and neutral oxides of meteoric species in the E region, with sulfur a main exception. It is suggested that $MgO_2^+ + O \rightarrow MgO^+ + O_2$ and $FeO_2^+ + O \rightarrow FeO^+ + O_2$ are exothermic reactions but that the process $SiO_2^+ + O \rightarrow SiO^+ + O_2$ may be endothermic. For the alkali ions, it is argued that the processes $Li^+, Na^+, K^+ + O_3 \rightarrow LiO^+, NaO^+, KO^+ + O_2$ are endothermic. The possible role of radiative association is discussed. (auth)(UK)

42078 THE ROLE OF ATOMIC OXYGEN IN THE IONOSPHERIC E- AND F-REGION BEHAVIOR. Herman, J. R.; Chandra, S. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 17: 1247-56(June 1969).

The continuity and heat conduction equations for the electron, ion, and neutral gases are solved simultaneously to show the effect of using the heat loss arising from the excitation of the fine structure levels of atomic oxygen, and the heat input from a height dependent electron heating efficiency. The solutions are compared to Thomson backscatter data obtained under conditions similar to those used in the theoretical model. A family of solutions is presented for three different values of the atomic oxygen density at the turbopause level, and compares favorably to certain widely observed features of the main phase of a magnetic storm. From the comparison it is shown that the results of decreasing the atomic oxygen density at the turbopause level are consistent with the observed changes in both the neutral and ionized constituents relative to quiet magnetic conditions. (auth)(UK)

42079 COMBINED WORLD-WIDE NEUTRAL AIR WIND AND ELECTRODYNAMIC DRIFT EFFECTS ON THE F2 LAYER. Abur-Robb, M. F. K. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 1269-79(June 1969).

Three time-varying solutions of the world-wide continuity equation for electrons in the F2 region are obtained under equinoctial conditions of symmetry. The effects of production, loss, diffusion, electrodynamic "E × B" drift and neutral air winds are taken into account. The three solutions correspond to various combinations of an "E × B" drift of amplitude 20 m/sec^{-1} and a meridional neutral air wind of maximum magnitude 100 m/sec^{-1}. The "E × B" drift chosen is simple harmonic, being upward during the day and downward at night. The meridional wind chosen is simple harmonic, being poleward during the period 4.5 to 16.5 hr LT and equatorward for the remaining period; it varies with latitude, has a latitudinal maximum at ±45° and vanishes both at the equator and at the poles. The results show that, at midlatitudes, wind effects alone can explain the observed diurnal variations in N_mF2 and that at equatorial stations winds combined with "E × B" drifts can be plain the observed noon bite-out and the post-sunset anomalous enhancement of N_mF2. The "E × B" drift produces a realistic equatorial anomaly and is responsible for the noon bite-out observed at the dip equator. Neutral air winds may be responsible for the maintenance of the nighttime equatorial F2 layer, for the considerable day-to-night change in h_mF2 and for a nighttime anomalous behavior in h_mF2 which is similar both to that observed in the winter hemisphere and to $h'F2$ observed during equinoctial months. Thus it is shown that neutral air winds combined with "E × B" drifts produce realistic ionospheric models. (auth)(UK)

42080 ELECTROMAGNETIC NOISE IN THE CURRENT SHEET IN THE GEOMAGNETIC TAIL. Dungey, J. W.; Speiser, T. W. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 17: 1285-90(June 1969).

It is stated that noise is not absolutely necessary for the existence of an electric field in the current sheet, although in practice noise is almost certainly important. Speiser's (1965) trajectory calculations neglecting noise lead to an unfamiliar kind of distribution function, which is clearly unstable in such a way as to generate longitudinal waves and possibly other waves. The stability criterion is, however, strongly affected by radiation out of the sides of the sheet. The complete problem is discussed in a general way, and it is pointed out that, depending on the character of the noise, the distribution function may or may not be radically altered by the noise. The problem is broken down into several parts. (auth)(UK)

42081 DAMPING OF WAVES IN THE CURRENT SHEET IN THE GEOMAGNETIC TAIL BY RADIATION. Dungey, J. W. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 17: 1291-6(June 1969).

In the preceding paper (loc. cit., 17: 1285-90) it was seen that the velocity distribution in the current sheet will give energy to waves, but that the overall stability problem involves the radiation of energy from the sides of the sheet. For waves propagating parallel to the current, the problem is simple; radiation occurs when a Cherenkov condition is satisfied and then the rate of radiation is large, so that the waves are probably damped. For waves propagating perpendicular to the current the problem is more complicated and there is typically an evanescent wave as well as a radiated wave. The rate of radiation may then be much smaller. (auth)(UK)

42082 ABSOLUTE TRANSITION PROBABILITY MEASUREMENT FOR THE ELECTRIC QUADRUPOLE 5577-A AURORAL GREEN LINE. McConkey, John W.; Kernahan, John A. (Queen's Univ., Belfast). Planet. Space Sci., 17: 1297-1306(June 1969).

The transition probability of the 5577 Å ($^1S_0-{}^1D_2$) line of oxygen was obtained absolutely by simultaneous measurement of the number density of $O(^1S_0)$ atoms in an oxygen–helium discharge and the intensity of the emitted 5577 Å line. The experimental technique is described in detail. The value of 1.0 sec^{-1} obtained for A-5577 is in agreement with theoretical predictions, though large systematic and other errors result in a possible inaccuracy by a factor of two. (auth) (UK)

42083 NEUTRAL-AIR WINDS IN THE IONOSPHERIC F REGION FOR AN ASYMMETRIC GLOBAL PRESSURE SYSTEM. Challinor, R. A. (Commonwealth Scientific and Industrial Research Organization, Camden, New South Wales). Planet. Space Sci., 17: 1097-1106(June 1969).

An extension is presented of a previous study by the author, in which a theoretical pattern of neutral-air winds, driven by pressure-gradients and moving ions, in the ionospheric F region, was derived. Several modifications are made to the method of analysis, including the use of a more detailed and realistic model of upper-air pressures. The new "asymmetric" pressure model has pressure maximum and minimum, not at diametrically opposed points of the Earth, but at 1400 and 0330 hr LMT, so that isobars are more crowded around sunset than around sunrise. As before, an equatorward wind exists at night, but this is much weaker at very low latitudes and is directed more toward the east. Other new features of the resulting wind system are a stronger, and longer lasting, evening eastward wind and a weaker morning westward wind. This results in a greater mean "rotation rate" for the upper atmosphere than previously derived. The predicted angular velocity of the atmosphere at 250 km is about 1.1 times that of the Earth, but the figure for medium and low latitudes is about 1.2, which compares favorably with the result of 1.3 given by satellite orbital data. The theoretical wind pattern agrees well with available observations. (auth)(UK)

42084 INFRASONIC WAVES FROM MOVING AURORAL ELECTROJETS. Wilson, Charles R. (National Center for Atmospheric Research, Boulder, Colo.). Planet. Space Sci., 17: 1107-20(June 1969).

The source regions of infrasonic waves observed at College, Alaska were identified with supersonic auroral electrojets which cross the zenith from the northwest during substorm activity. By the use of an infinite line current approximation the speed, direction of motion, and zenith crossing time were determined for the electrojets from their surface magnetic perturbations. The directions of motion of the electrojets and of the infrasonic wave surfaces are in good agreement. A comparison of the speed of auroral electrojets, however, determined on the one hand by estimating $d(B_Z/B_H)dt$, on the basis of the observed values of

ΔH and δZ, and on the other hand by auroral photographic measurements, indicates that return currents and induced Earth currents cause the velocities derived from magnetograms to be too small by a factor of two. Nevertheless, magnetic analysis can establish a lower limit to the electrojet speed to determine whether or not it can be a source of auroral infrasonic shock waves. (auth)(UK)

42085 TWILIGHT ENHANCEMENT OF THE AURORAL AND NEBULAR LINES OF NEUTRAL ATOMIC OXYGEN. Deehr, Charles Sterling. College, Univ. of Alaska, 1968. 150p.
Thesis.

A study of the auroral (5577 A) and nebular (6300 A) emissions of [OI] in the twilight airglow was carried out at Alaska (65°N, 147°W) during the IQSY period (1963−1965). An analysis of morning twilight observations, taken with a birefringent filter photometer, showed the twilight enhancement of both emissions to be due to photodissociation of O_2. Analytical expressions were developed which described the intensities to be expected from this mechanism in the twilight and then the physical parameters used in these expressions were varied to match the intensities observed under changing atmospheric conditions. Because only one production mechanism was important, it was possible to draw conclusions about the physical processes involved and about the state of the atmosphere at the time of the observation. (TSS) (Disser. Abstr.)

42086 LUNAR TIDAL VARIATIONS IN f_0F_2 IN THE AMERICAN ZONE DURING PERIODS OF LOW SOLAR ACTIVITY. III. MIDDLE LATITUDE STATIONS: PUERTO RICO AND FALKLAND. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 69: 250-64(May 1969).

Lunar semi-diurnal (L_2) or lunar semi-monthly (M_2) tides in f_0F2 at Puerto Rico and Falkland are shown to be a maximum during D-months (November to February) and least during J-months (May to August). The lunar daily variations of f_0F2 at different lunar ages conform to Chapman's Phase law derived from the atmospheric dynamo theory for geomagnetism. The M_2 tide at different solar hours indicates two maxima around 12 and 21 solar hours. At Puerto Rico the M_2 tide is controlled by lunar time during D- and E-months and by lunar age during J-months. At Falkland, during D- and E-months, the M_2 tide for daytime hours is controlled by lunar time while that for the nighttime hours is controlled by the lunar age. Thus the tidal movements in the F2 layer have control depending on the absolute position of the Moon as well as on the relative positions of the Sun and Moon, the relative importance of the two changes with the season or between day and night hours. (auth)

42087 AURORAL PULSATIONS AND FLAMING: SOME INITIAL RESULTS OF A CINEMATOGRAPHIC STUDY USING AN IMAGE INTENSIFIER. Scourfield, M. W. J.; Parsons, N. R. (Univ. of Calgary, Alberta, Can.). Planet. Space Sci., 17: 1141-7(June 1969).

Examples are given of pulsating patches, one class of which showed no quasi-periodicity but nevertheless exhibited remarkably consistent emission times throughout the pulsation cycle. From records of flaming auroras, upward field-aligned speeds of 75 to 130 km/sec were calculated for the luminosity enhancement. If this upward flaming is interpreted as due to velocity dispersion of a burst of precipitating electrons originating simultaneously in a localized region along the appropriate magnetic field line, the calculated distances of this region out along the field line range from 2.5 to 4 R_E. Two observations of downward flaming, together with calculated speeds, are also reported. (auth) (UK)

42088 MID-LATITUDE RADIO-SATELLITE SCINTILLATION: MORPHOLOGY NEAR SUNSPOT MINIMUM. Preddey, G. F. (Victoria Univ., Wellington, New Zealand); Mawdsley, J.; Ireland, W. Planet. Space Sci., 17: 1161-71(June 1969).

The morphology of 40 MHz radio-satellite scintillation for the ascending phase of the present sunspot cycle is described for a chain of mid-latitude to subauroral stations near 170°E longitude in the southern hemisphere. Diurnal, seasonal, and latitude variations of scintillation, its association with sporadic-E and spread-F, and its dependence on magnetic activity are described. (auth) (UK)

42089 FUNCTION FOR PARTICLE DISTRIBUTION AT PITCH ANGLES TAKING INTO ACCOUNT THE EARTH GRAVITATIONAL FIELD. Oberts, Pavel (Univ., Warsaw). Acta Geophys. Pol., 17: 75-9(1969). (In Russian).

The distribution function for thermal protons in the magnetosphere was obtained taking into account the gravitational field. An integral equation coupling the density distribution along the field line with the pitch-angle particle distribution was found. It was established that electric charge conservation demands variable pitch-angle distribution for electrons and protons. (tr-auth)

42090 ANOMALOUS FEATURES OF THE ELECTRON DENSITY IN THE TOPSIDE IONOSPHERE. Sayers, J.; Wilson, J. W. G.; Loftus, B. (Univ. of Birmingham, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 501-16(Aug. 12, 1969).

A description is given of the instrumentation of the Ariel III satellite for the above study, and of the results obtained for electron density and temperature. The experiment was calibrated to detect electron temperatures in the range 0° to 4500°K, and the e.d. channels could detect densities in the range 2×10^2 to 1.2×10^6 cm^{-3}. Electron densities and temperatures recorded around one orbit on 12th May 1967 are shown graphically. The e.t. curve at low and middle latitudes clearly shows the inverse relation with e.d. expected from theory, but the smoothly varying distribution of temperature with latitude disappeared at high latitudes, where departures from the inverse correlation between temperature and density were observed. Temperatures rise from 1000 to 2000°K at low latitudes to >4500°K in the polar regions. A division of the e.d. distribution at 500 to 600 km, into distinct zones was observed. The distribution shows a maximum density of 8.5×10^5 cm^{-3} at the equator, with an initially rapid decrease with increasing latitude; the densities in the mid-latitudes, however, remain almost constant, with average values in the N summer hemisphere approximately twice those in the S winter hemisphere. Both mid-latitude regions are abruptly terminated at high latitudes by a main trough which is deeper in the S hemisphere during early evening than at midnight in the N hemisphere. Polewards of the troughs of the e.ds. become very irregular, since these are the regions where the ionisation produced by sporadic streams of inflowing charged particles dominates that due to solar electromagnetic radiation. This is also indicated by the fact that the polar density levels are similar in the two hemispheres despite the seasonal difference. The plots obtained may be used to follow the local time variation of e.t. and e.d. in any region. A general decrease in e.d. was shown at all latitudes during the evening, probably due to both cooling and subsidence of the atmosphere, and to the increasing importance of recombination processes in the nighttime ionosphere. It is noted that the topside ionosphere is often the seat of large disturbances occurring as an aftermath of solar flares, and the Ariel III surveys are ideally suited to studies of the development, etc. of flare effects. Some of the complicated processes occurring during storm times are illustrated. Studies of the main trough, its diurnal behavior, and its movement to lower L values during magnetic disturbances, will play an important role in explanation of the processes governing particle precipitation at higher magnetic latitudes during both quiet and disturbed magnetic times. (UK)

42091 V.L.F. OBSERVATIONS ON ARIEL III. Bullough, K.; Hughes, A. R. W.; Kaiser, T. R. (Univ. of Sheffield, Eng.). Proc. Roy. Soc. (London), Ser. A, 311: 563-90(Aug. 12, 1969).

The vlf experiment on Ariel III is designed to make a synoptic study of the worldwide distribution and occurrence of vlf electromagnetic wavefields above the ionosphere using a multi-channel receiver with a loop aerial. A preliminary examination was made of data obtained during some 200 satellite revolutions. It was found convenient to divide the observed phenomena into four main classes: (a) Man made transmissions. These are signals transmitted at 16 kHz from GBR (Rugby), U.K. and at 15.5 kHz from NWC (Australia). (b) Medium and low latitude emissions. These usually have a well-defined high latitude boundary—probably the plasma pause. (c) High latitude "hiss." This well-defined zone of broad band noise occurs at invariant latitudes, Λ, greater than 60° (L = 4) and was observed on the majority of revolutions. It is probably associated with the inner zone of soft electron (few keV) precipitation located outside the trapping boundary. (d) Thunderstorm emissions. The sferic impulses of large signal amplitude, generated in lightning discharges, are a powerful probe for the study of D-region phenomena and of geomagnetic field-alined structure in the ionosphere and magnetosphere. The occurrence and behaviour of these phenomena are discussed in relation to the structure of the magnetosphere and to magnetic storm effects. The equatorial arch of enhanced ionization is also found to have a marked effect on the vlf wavefields. (auth) (UK)

42092 ELECTROMAGNETIC WAVE SCATTERING BY IONOSPHERIC IRREGULARITIES. Hayakawa, Masashi; Ohtsu, Jinsuke (Nagoya Univ., Japan). Proc. Res. Inst. Atmos., Nagoya Univ., No. 16, 53-63(Jan. 1969).

This paper deals with the scattering of electromagnetic waves obliquely incident on an inhomogeneous plasma column which has a parabolic radial density distribution and its application to ionospheric irregularities. Explicit expressions of scattered wave fields and fields inside the irregularity are given. Formulas of scattering patterns are given analytically as functions of frequency, incident angle, and irregularity width. As special cases, scattering by a magnetic field-aligned irregularity at normal incidence, and scattering by irregularities with regular spatial distribution, are also discussed. (auth) (NSA of Japan)

42093 DUCTED PROPAGATION OF HYDROMAGNETIC WHISTLERS IN THE MAGNETOSPHERE. Hamakawa, Masashi; Ohtsu, Jinsuke (Nagoya Univ., Japan). Proc. Res. Inst. Atmos., Nagoya Univ., No. 16, 91-100(Jan. 1969).

The guiding mechanism of hydromagnetic whistlers along the Earth's magnetic field-aligned plasma column in the magnetosphere was investigated by use of wave theory. The radial density distribution perpendicular to the magnetic field is assumed to be Gaussian and the method in which the fields are expanded into power series of the radial distance from the column axis was used. The condition for trapping in a duct is discussed for enhanced, and depressed, ducts. The existence of trapping frequency region, which is closely related to the duct modulation factor, is demonstrated and the duct width necessary for trapping is also estimated. (auth) (NSA of Japan)

42094 COLLISION PROCESSES IN THE IONOSPHERE. I. Rath, Gudrun (Univ., Graz). Acta Phys. Austr., 28: 165-76 (1968). (In German).

The various types of collisions which the electrons undergo with the ionospheric particles are represented; two large groups, inelastic and elastic, are distinguished. Through each inelastic collision the electrons lose suddenly a certain energy contribution, which is equal to the excitation or ionization energy of the bombarded molecule or atom. Since this energy contribution is much larger than that transferred by elastic collisions to the slowing-down particle, and since the probability for an inelastic collision is much larger than for an elastic collision, it is proven that the energy of the fast electrons is reduced in the first place by inelastic collisions. Only the residual energy remaining, after all inelastic collisions, is available for the temperature increase of the ionosphere constituents. As is evident from the effective cross sections for elastic collisions and from the mean energy loss for all types of elastic collisions, the elastic electron–electron collisions must be regarded as the most braking of all elastic collisions. It is shown however that the residual energy of the fast electrons remaining after all inelastic collisions is distributed to all surrounding thermal (that is, already becoming slower) electrons and their kinetic energy increases. Through the new formation of fast electrons starting at sunrise first the electron gas is warmed faster or stronger than the usual constituents of the ionosphere. During the day, however, processes occur which lead to an equilibrium between these various temperatures of the two components. The electron gas temperature reaches a maximum at a certain time of the day, which was observed. The corresponding theoretical investigations are considered in Part II. (tr-auth)

42095 INTENSITY RATIO OF 6300 AND 5577-A O I EMISSIONS IN QUIET AURORA. Murcray, W. B. (Univ. of Alaska, College). Planet. Space Sci., 17: 1429-31(July 1969).

The intensity ratio of the atomic oxygen red and green lines is of some importance in the discussion of atmospheric processes, since it provides information as to the quenching rate of OI'D and to the relative excitation rates of OI'D and OI'S. Previous data in regard to the aurora are sparse and not very reliable, but it is shown that the situation is much better if the aurora is measured from a rocket; the quenching so obtained is in good agreement with dayglow results. (UK)

42096 DEPENDENCE OF THE MICROPULSATION PERIODS ON THE SIZE OF THE MAGNETOSPHERE. Patel, V. L.; Hastings, R. N. (Univ. of Denver). Planet. Space Sci., 17: 1432-4(July 1969).

The possible relationship between the micropulsation periods (T) which can be propagated in the magnetosphere and the size of the magnetosphere (R_m) is studied. The radial distance R_m in Earth radii denotes the location of the magnetopause from the centre of the Earth. Details of the analysis are described, and the relationship between T and R_m is expressed in the form of a power law. An attempt is made to interpret these results in terms of the wave propagation in three natural divisions of the magnetosphere. (UK)

42097 MODERN VIEW OF THE IONOSPHERE AND ITS EXAMINATION. Triskova, Ludmila. Pokroky Mat. Fyz. Astron., 13: 356-67(1968). (In Czech).

The most important studies on the ionosphere are reviewed, defining it as that portion of the terrestrial atmosphere which contains free ions and electrons in quantities sufficient to affect the propagation of radio waves. Its approximate boundaries are 60 to 100 km. The behavior of the undisturbed region of the ionosphere—the region unaffected by extraordinary solar activity—is closely examined. The basic properties of the ionized region are determined by the density of the atmosphere which decreases with altitude and the solar radiation effects which decrease toward the Earth. The ionosphere is divided into D, E, and F zones. The D zone, located at about 60 to 95 km has an electron density of 10 to 10^3–10^4 electrons cm^3 at those respective boundaries. In the E zone, lying at about 95 to 140 km, the values at the boundaries are 8×10^4 and 2×10^{15} electrons/cm^3. Research problems in the ionosphere are of interest for communications and weather prediction. The Sun's activity generates changes especially in the F zone of the ionosphere. Modern research is greatly facilitated by the development of the rocket and satellite technology. (TTT)

42098 PROPAGATION OF ELECTROMAGNETIC STEP-FUNCTION WAVES IN THE IONOSPHERE. Ollendorff, Franz (Technion City, Haifa, Israel). Arch. Elektrotech. (Berlin), 52: 286-300(1969). (In German).

An introduction to the electromagnetic processes accompanying the penetration of a wave front into the ionosphere is developed. The derivation follows through consideration of instantaneous switching of direct current, front electrical excitation of the ionosphere, and entrance of a step-function wave into the ionosphere. Reflected waves are also calculated. The problem of multiple reflection in an ionospheric layer is discussed. In reality the problem is more complex, since the ionosphere possesses no sharp limiting plane, and in addition waves are dampened by collisions of electrons with positive or neutral particles. Appendices list evaluations of several integrals associated with the theory presented and consider problems of repeated wave reflections. The model provides a more accurate description of the real ionosphere, though refinements must be made. (BBB)

42099 OBSERVATIONS OF SCINTILLATIONS BY SATELLITE SIGNALS AT 40 MHz. Muenther, Christian (Ionosphaeren-Institut, Breisach am Rhein, Ger.). Arch. Elek. Uebertrag., 23: 219-20(Apr. 1969). (In German).

The field strength of the 40-MHz signal of the Explorer 22 satellite was recorded. Data for the observation period from October 1964 to August 1967, with 2 or occasionally 3 observations per day, account for 1670 satellite crossings. For the total period no correlation between scintillation values and sunspot relative numbers was found. For the year 1966 no correlation between scintillation values and terrestrial magnetic 3-hr values K was observed. Scintillation values measured during the day showed no correlation with the season; values measured at night showed maxima in November/December and June/July with a maximum value of 7% and a minimum of 5%. Frequency distribution of the scintillation index had a variation with the time of day, with a maximum of 8% between midnight and 0300 UT and a minimum of 2% between 1200 and 1500 UT. Cases of strong scintillation showed a daily variation as well. (BBB)

42100 THE HEOS-A SATELLITE PROJECT. Jorissen, H. Dieter Luftfahrttech.-Raumfahrttech., 14: 169-71(July-Aug. 1968). (In German).

Objectives of the third research satellite of ESRO, HEOS-A, include measurements of magnetic and electric fields and particle currents in the magnetosphere, measurements of the interplanetary magnetic field, measurements to evaluate anisotropies in cosmic radiation from protons emitted in solar eruptions, investigations of direction distributions, density distributions, and energy distributions in the positive components of the solar wind, measurements of protons, electrons, and α particles with solar and galactic origin, and measurements of electrons of undisturbed cosmic primary radiation. General features of construction of the satellite and of its transmission system are described and illustrated. Data from the satellite are transmitted at 136.65 MHz and commands are sent to the satellite at 148.25 MHz. Launch is scheduled for December 1968/beginning 1969. An apogee of 200,000 to 300,000 Km is necessary for magnetosphere and shock wave experiments. (BBB)

42101 A NUMERICAL STUDY OF PARTICLE ACCELERATION IN THE MAGNETOSPHERE. Tamao, Tsutomu; Ashihara, Osamu (Tokyo Univ.). Inst. Space Aeronaut. Sci., Univ. Tokyo Rep., 34: 1-14(Jan. 1969).

As a first step in the quantitative study of wave–particle interaction in the complicated magnetospheric situation, the problem of the Fermi acceleration of energetic electrons trapped in the geomagnetic dipole field by the large-amplitude compressive pulse propagating along the particular field line was numerically analyzed. The condition of magnetic moment conservation is specified. Associated with the geomagnetic sudden commencement, if this pulse propagates from the equator to high latitudes along the particular field line, multiple head-on collisions of the particle with the moving pulse yield the net acceleration and secular lowering of the mirror point, until the mirror point is overtaken by the pulse. Assuming a model distribution of the plasma density and Poynting flux conservation of the pulse during its proagation, the motion of an interacting electron is determined in detail for various initial equatorial pitch angles. It is shown that the acceleration by this process is most effective for trapped particles near the equator. These results indicate that the appreciable particle precipitation associated with the geomagnetic sudden storm commencement cannot be determined by consideration only of the Fermi process; other more intense acceleration mechanisms are operable in the real magnetosphere. (BBB)

42102 THE CONDUCTIVITY OF LOWER IONOSPHERE DEDUCED FROM SUDDEN ENHANCEMENTS OF STRENGTH (SES) OF VLF TRANSMISSIONS. Yamashita, Michiko (Nagoya Univ., Japan). J. Atmos. Terrest. Phys., 31: 1049-587(Aug. 1969).

The modal equation is solved with use of the sharply bounded and homogeneous ionospheric model. The conductivity parameter of the lower ionosphere is discussed, comparing the theoretical results with experimental data of SES phenomena in the vlf transmissions reported by Kaufmann (1967, 1968). As a result it is seen that, under the undisturbed ionosphere, the reflection height of vlf is about 70 km and its ionospheric conductivity parameter ω_r is about 2 to 5 × 10^4/sec. (auth) (UK)

42103 DAYTIME ION COMPOSITION IN THE HEIGHT RANGE OF 150 TO 1500 KM FOR SOLAR MINIMUM CONDITION. Bhatnagar, V. P. (National Physical Lab., New Delhi). J. Atmos. Terrest. Phys., 31: 1059-76(Aug. 1969).

An ion composition model for the height range 150 to 1500 km, likely to hold for daytime at moderate latitudes for minimum solar activity ($F_{10.7}$ = 70 units) was developed. It is based on the neutral atmospheric model given by Bhatnagar and Mitra (1966), solar ionizing flux data given by Hinteregger et al. (1965), and the electron and ion temperatures given by Evans (1965) close to minimum solar activity period. The topside ionosphere was considered as a ternary mixture of atomic oxygen, helium, and atomic hydrogen ions. The calculated distribution of O^+ agrees with that observed in the bottomside F2 region, if the rate coefficients k_1 and k_2 for the charge exchange between O^+ and N_2, and O^+ and O_2 have values of about (0.9 to 1.0) × 10^{-12} cm^3/s and (0.9 to 1.0) × 10^{-11} cm^3/s respectively, at F-region temperatures. These values agree within a factor of 2 with measured laboratory values. In the case of helium ions a reasonable agreement between the calculated and observed values is obtained, if the rate coefficients k_3 and k_4 for the charge exchange between He^+ and N_2, and He^+ and O_2 have values of about 10^{-11} cm^3/sec. In the case of atomic hydrogen ions, agreement between the calculated and observed values is obtained, if the neutral atomic hydrogen distribution from the atmospheric model is increased by a factor of about 5 to 10. It is concluded that the electron and ion temperatures in the topside ionosphere above about 500 km, obtained from incoherent scatter technique, are larger than those required to explain the observed ionic composition at dip values around 60° for low solar activity conditions. (auth) (UK)

42104 CHANGES IN ELECTRON DENSITY AND COLLISION FREQUENCY AT UNIVERSITY PARK, PENNSYLVANIA DURING THE STRATOSPHERIC WARMING OF 1967/68. Rowe, John N. (Pennsylvania State Univ., University Park); Ferraro, A. J.; Lee, H. S.; Mitra, A. P. J. Atmos. Terrest. Phys., 31: 1077-84(Aug. 1969).

The electron-density and collision-frequency profiles obtained from the high power wave interaction observations at Pennsylvania State University were examined for possible changes during the stratospheric warming of December 1967 to January 1968. The electron density increased quite sharply above 70 km, with maximum enhancement (about a factor of 10) at about 75 to 80 km. No change was observed in the collision frequency at heights between 50 and 90 km, and there was no significant change in the electron density below 70 km. From examination of the electron density and absorption data it appears that the effect began in early December, 1967, reached a maximum between December 25 and January 1, and ended about January 20, 1968. There is some indication that the diurnal variation in electron density at 80 km became slower during the warming than during normal days, possibly indicating increasing control of ionization production through L_α. (auth) (UK)

42105 ON SOME RELATIONSHIPS BETWEEN CORRELATION ANALYSIS AND SIMILAR-FADE ANALYSIS RESULTS OF DRIFT MEASUREMENTS IN THE LOWER IONOSPHERE. Sprenger, K. (Heinrich-Hertz Institute fuer Solar-Terrestrische Physik, Berlin); Schminder, R. J. Atmos. Terrest. Phys., 31: 1085-98(Aug. 1969).

In the comparisons hitherto made between similar-fade analysis results and correlation analysis results of ionospheric drift measurements two essential facts seem to have been left out, namely: (i) there are at least two different ways of making similar-fade analysis, which often yield quite different magnitudes of drift velocity, and (ii) the similar-fade method is confined preferably to the short-period components of the fading and, therefore, its results may not be a priori comparable with the results of a correlation analysis which includes the long-period fading components. From investigations of ionospheric drift measurements in the lf range at medium latitude it can be shown that there are close relationships between similar-fade and correlation analysis results, if correlation analysis is performed after submitting the original fading curves to a mathematical filter which suppresses the long-period fading components. The drift velocity obtained from one variant of the similar-fade method (the method of averaging time delays) is very similar to the term "apparent drift velocity" in the correlation analysis, whereas the drift velocity obtained from the other variant of the similar-fade method (the method of averaging drift vectors) is very similar to the term "true drift velocity" in the correlation analysis. Even the term "chaotic velocity" can approximately be found from the similar-fade method by combining the results of the two variants according to a formula borrowed from the correlation analysis formalism. These relationships, though not yet founded mathematically, are expected to be generally valid also at higher frequencies and in other latitudes, so far as there is no extreme anisotropy of the ionospheric irregularities. (auth) (UK)

42106 THE PHASE OF WAVES PARTIALLY REFLECTED FROM THE LOWER IONOSPHERE (70 TO 120 KM). Austin, G. L.; Bennett, R. G. T.; Thorpe, M. R. (Univ. of Canterbury, Christchurch, N. Z.). J. Atmos. Terrest. Phys., 31: 1099-1106 (Aug. 1969).

A method of recording the phase as well as the amplitude of radio waves reflected from the D and E regions of the ionosphere is described. Because of the finite pulsewidth, the returned echo is a "moving average" of the echo that would result from a very short pulse. If both amplitude and phase information is available this smoothing process may be inverted by standard Fourier methods, giving improved time resolution. This technique is applied to some data obtained, using a frequency of 2.4 MHz and a pulse length of 25 μsec. (auth) (UK)

42107 PERTURBATIONS IN A NONLINEAR F REGION AT NIGHT. Cummack, C. H. (Dept. of Scientific and Industrial Research, Christchurch, N. Z.). J. Atmos. Terrest. Phys., 31: 1107-18(Aug. 1969).

The effects of nonlinear recombination and variable drift in the nighttime F region are examined. It is found that close agreement with observations is possible and a wide variety of ionograms may be synthesized. (auth) (UK)

42108 THE HYSTERESIS VARIATION IN F2-LAYER PARAMETERS. Gopal Rao, M. S. V.; Rao, R. Sambasiva (Defence Electronics Research Lab., Hyderabad, India). J. Atmos. Terrest. Phys., 31: 1119-26(Aug. 1969).

The variations in f_0F2 and M(3000)F2 with sunspot number for the 19th solar cycle are studied to assess the difference between the rising and falling parts of the solar cycle. Such differences, which may be termed hysteresis, are evaluated for several stations. In the case of f_0F2 the magnitude of hysteresis is found to vary systematically with geomagnetic latitude, being minimum at equatorial and high latitudes and a maximum at mid-latitudes on either side of the equator. The M(3000)F2 factor also shows considerable hysteresis, but without any systematic latitude variation. The results are discussed in the light of a hysteresis effect observed in the variation of magnetic activity with the sunspot number. (auth) (UK)

42109 EFFECT OF MAGNETIC ACTIVITY ON DRIFTS AND ANISOTROPY OF E-REGION IONIZATION IRREGULARITIES OVER AHMEDABAD. Kaushika, N. D. (Univ. of Delhi). J. Atmos. Terrest. Phys., 31: 1127-9(Aug. 1969).

Results of a study of the effect of magnetic activity on horizontal drifts, and anisotropy and random change characteristics of E-region ionization irregularities measured at Ahmedabad during the period January 1965 through June 1966 by the spaced-receiver technique are presented. (auth) (UK)

42110 DIRECT DETECTION OF IONOSPHERIC IRREGULARITY. Checcacci, P. F. (Istituto di Ricerca sulle Onde Elettromagnetiche, Florence). J. Atmos. Terrest. Phys., 31: 1131-3(Aug. 1969).

A device for the direct detection of ionospheric irregularities was flown on board the 1967-38A San Marco Satellite. This device utilizes the fluctuation induced in the impedance of the satellite antenna by the irregularity. Features of the device, as well as typical irregularities observed along the satellite orbits, are presented. (auth) (UK)

42111 EFFECTS OF POLAR-CAP-ABSORPTION EVENTS ON VLF TRANSMISSIONS. Westerlund, S. (Kiruna Geophysical Observatory, Sweden); Reder, F. H.; Abom, C. Planet. Space Sci., 17: 1329-74(July 1969).

Following a brief review of Hakura's (1965 and 1967) model of a polar cap absorption event (PCA), vlf instrumentation, and data reduction problems, eleven PCAs are studied for their effects on phase and amplitude of vlf transmissions. The eleven PCAs occurred between March 24, 1966 and June 6, 1967. Vlf phase anomalies are always advances $(\Delta\Phi)$, the magnitude of which increases with increasing geomagnetic latitude of the path, decreasing signal frequency, and decreasing electrical ground conductivity. Signal strength falls by more than 15 dB/1000 km for paths with very low electrical ground conductivity (Greenland and Antarctic Ice Cap), whereas it may increase by a few dB for polar paths over sea water. It is shown that normalization of $(\Delta\Phi)$, with respect to frequency and affected path length, leads to two distinct linear relationships between $(\Delta\Phi)$ and $(\log \log F/F_0)$, where F is the proton flux as measured by satellites. The line of lower slope applies to paths over a highly conducting boundary (sea water), and the line of higher slope to a poorly conducting boundary (ice). The minimum detectable proton flux is 0.5 protons/cm^2 sec ster. The $(\Delta\Phi)$-$(\log \log F/F_0)$ relationship implies a decreased sensitivity of $(\Delta\Phi)$ to changes in F for larger values of F, an almost uniform vlf reflection height over the polar cap, little influence on reflection height of the shape of the flux spectrum during peak flux, and an upper limit of approximately 25 μsec for a PCA phase anomaly on NPM (26.1 kHz)-Kiruna. Occasionally irreversible cycle advances were observed on NPG-STO and WWVL-STO. The former are interpreted in terms of enhanced mode conversion and the latter in terms of the tracking of an interfering vlf signal. An event on December 13, 1966 is believed to have been due to electron precipitation from the outer radiation belt. (auth) (UK)

42112 SOME FEATURES OF THE EQUATORIAL ELECTROJET. Stening, R. J. (Univ. of Queensland, Brisbane). Planet. Space Sci., 17: 1375-89(July 1969).

The equivalent circuit method of Stening (1968) is used to calculate current distributions in the vicinity of the equatorial electrojet. Both height and latitude profiles are obtained, which show reasonable agreement with observations. The tube of magnetic force model employed in the calculations is useful in understanding some of the variations in the electrojet. Changes in height of the electron density profile correlate with changes in the maximum current density of the electrojet. Two further problems are discussed: (1) the double peak structure in the current density height profile, and (2) the relationship between the instabilities observed by vlf backscatter and ground-based magnetic measurements. (auth) (UK)

42113 WAVE MOTIONS ASSOCIATED WITH PARTICLE PRECIPITATION IN THE IONOSPHERE. Rai, D. B. (Univ. of Alaska, College). Planet. Space Sci., 17: 1391-3(July 1969).

Some observational evidence for the existence of waves caused by particle precipitation in the auroral ionosphere is presented. The nature of these wave motions strongly suggests that the waves are a manifestation of instabilities in the ionospheric plasma. The observed characteristics of these waves and the theoretical aspects of the instability are discussed. (auth) (UK)

42114 ON THE DYNAMICS OF THE DP-CURRENT SYSTEM. Grafe, A. (Adolf-Schmidt-Observatorium fuer Erdmagnetismus, Niemegk, Ger.). Planet. Space Sci., 17: 1395-1408(July 1969).

For the two geomagnetic storms on July 8, 1966, and August 29, 1966, electric-current systems of the DP variation were derived for several points of time. The different forms of these current systems are discussed. Changes from unicellular into bicellular forms are characteristic of a variable DP-current system. (auth) (UK)

42115 ABSENCE OF THE HYDROGEN EMISSION (Hβ) IN THE WESTWARD TRAVELING SURGE. Akasofu, S.-I. (Univ. of Alaska, College); Eather, R. H.; Bradbury, J. N. Planet. Space Sci., 17: 1409-12(July 1969).

It is shown that a westward traveling surge observed on March 3, 1968, was associated with an electron flux of order 4×10^9/cm^2 sec, while the Hβ emission was absent (≤2 R). It is suggested that the electron flux constitutes an upward (field-aligned) electric current from the surge, which is the western end of the auroral electrojet. (auth) (UK)

Low-Temperature Physics

Refer also to abstracts 40923, 41135, 41528, 41532, 41677, 42390, 42395, 42478, 42525, 42784, and 42786.

42116 (BNL-50155(Pt.1)) PROCEEDINGS OF THE 1968 SUMMER STUDY ON SUPERCONDUCTING DEVICES AND ACCELERATORS. PART I. (Brookhaven National Lab., Upton, N. Y.). 1968. 376p. (CONF-680621-(Pt.1)). Dep. CFSTI.

Separate abstracts were prepared for the two sections. (M.O.W.)

For abstracts of individual sections see: 42117 and 42784.

42117 (BNL-50155(Pt.1), pp 193-375) CRYOGENICS. (Brookhaven National Lab., Upton, N. Y.).

CRYOGENICS—development in Europe
  —material development for
EPOXY RESINS—mechanical properties at cryogenic temperatures
HELIUM—heat transfer data compilation for
  —thermodynamics of, data compilation for
MAGNETS—refrigeration development for superconducting, for beam transport outside 200-GeV synchrotron
NICKEL ALLOYS AND SYSTEMS—mechanical properties of K-Monel, Onconel 718, Hastelloy R-235, TD nickel, electroformed nickel, Rene 41, and Hastelloy B, at cryogenic temperatures
REFRIGERATION—development for 4°K research
  —conference on
  —development for super-conducting beam transport magnets for 200-GeV synchrotron
VACUUM PUMPS—theory for cryopumping
WIRES—development for cryogenic applications (M.O.W.)

42118 (BNL-50155(Pt.2)) PROCEEDINGS OF THE 1968 SUMMER STUDY ON SUPERCONDUCTING DEVICES AND ACCELERATORS. PART II. (Brookhaven National Lab., Upton, N. Y.). 1968. 331p. (CONF-680621-(Pt.2)). Dep. CFSTI.

Separate abstracts were prepared for the two sections. (M.O.W.)

For abstracts of individual sections see: 42119 and 42120.

42119 (BNL-50155(Pt.2), pp 377-510) SUPERCONDUCTING MATERIALS. (Brookhaven National Lab., Upton, N. Y.).

NIOBIUM ALLOYS AND SYSTEMS—Nb-Sn, fabrication and properties of superconducting
  —Nb-Ti, properties of superconducting
  —Nb-Zr, mechanical properties of superconducting
SUPERCONDUCTORS—structure and properties of high-field
  —critical current behavior of hard (T)
  —critical fields of type-III, (T)
  —radiation effects on properties of, research on (E)
  —fabrication and properties of niobium-tin
  —physical properties of composite
  —mechanical properties of composite
TIN ALLOYS AND SYSTEMS—Nb-Sn, fabrication and properties of superconducting
TITANIUM ALLOYS AND SYSTEMS—Nb-Ti, properties of superconducting
ZIRCONIUM ALLOYS AND SYSTEMS—Nb-Zr, mechanical properties of superconducting (M.O.W.)

42120 (BNL-50155(Pt.2), pp 511-708) AC EFFECTS AND FLUX PUMPS. (Brookhaven National Lab., Upton, N. Y.).

MAGNET COILS—electrical loss measurements in superconducting niobium-titanium alloys (E)
  —design and development for use as flux pumps for superconductors
NIOBIUM—energy losses in superconducting, ac (F)
NIOBIUM ALLOYS AND SYSTEMS—Nb-Zr, ac losses in superconducting (E)
  —Nb-Ti, ac losses in superconducting (E)
  —Nb-Ti, electrical loss measurements in superconducting magnets of (E)
  —Nb-Sn, ac losses in superconducting ribbons of intermetallic Nb_3Sn (E)
  —Nb-Sn, magnetic and thermal instabilities in Nb_3Sn (E)
  —magnetic flux jump in superconducting Nb_3Sn, effects on
SUPERCONDUCTORS—energy losses in, ac (E)
  —energy losses in niobium-tin ribbon, ac (E)
  —resistivity of hard, in perpendicular time varying fields (E)
  —magnetic instabilities in high-field (E/T)
  —magnetic flux jumps in niobium-tin, effects on
  —magnetic flux pumps for, design and development of
TIN ALLOYS AND SYSTEMS—Nb-Sn, ac losses in superconducting ribbons of intermetallic Nb_3Sn (E)
  —Nb-Sn, magnetic and thermal instabilities in Nb_3Sn (E)
  —magnetic flux jump in superconducting Nb_3Sn, effects on
TITANIUM ALLOYS AND SYSTEMS—Nb-Ti, ac losses in superconducting (E)
  —Nb-Ti, electrical loss measurements in superconducting magnets of (E)

ZIRCONIUM ALLOYS AND SYSTEMS—Nb–Zr, ac losses in superconducting (E) (M.O.W.)

42121 (BNL-tr-276) A NEW METHOD OF OBTAINING VERY LOW TEMPERATURES. Neganov, B. S. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from a Russian reprint. 11p. Dep. CFSTI.

The history and advantages of the helium-3–helium-4 dilution refrigeration method are summarized. An apparatus of this type is sketched and areas of application are mentioned briefly. (M.H.R.)

42122 (IS-T-312) SURFACE SUPERCONDUCTIVITY IN HIGH PURITY NIOBIUM. Ostenson, Jerome Edward (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 79p. Dep. CFSTI.

Thesis.

At temperatures very close to the superconducting critical temperature, the nucleation field H_{c3} does not agree with the predictions of Saint James and de Gennes. As T approaches T_c, the ratio $C = H_{c3}/H_{c2}$ approaches 1.0 rather than the theoretical value of 1.7. Deviations from the theory have an exponential temperature dependence with a characteristic interval of about 0.133 K. (auth)

42123 TEMPERATURE AND FIELD DEPENDENCE OF FLUX FLOW RESISTIVITY IN TYPE-II SUPERCONDUCTORS. Axt, Carl Joseph. Cincinnati, Univ. of Cincinnati, 1968. 87p.

Thesis.

The dc differential flux flow resistivity, $\rho_F = dV/dI$, of type-II superconducting foils is studied as a function of magnetic field and temperature in alloys with a range of values of the surface energy parameter, K. Most of the data is obtained on the Pb–Tl system. Some of the results are reported with the In–Bi system. (Diss. Abstr.)

42124 SUPERCONDUCTIVITY IN THIN FILMS OF TUNGSTEN. Basavaiah, Suryadevara. Philadelphia, Univ. of Pennsylvania, 1968. 189p.

Thesis.

Evaporated tungsten films were found to have a superconducting transition temperature, T_c, of 3.2°K as compared to the bulk value of 0.01°K. Structural study of the electron-beam-evaporated W films was carried out by both x-ray and electron-diffraction techniques. It was found that films prepared at pressures $>10^{-7}$ torr, and evaporation rates <30 Å/min are a mixture of both α and β phases, the β phase being the A15 structure, and the α phase being the bcc structure. It was established that the enhancement in T_c of these films is due to the presence of the β phase. Films prepared at 3×10^{-8} torr are pure α-W and they did not superconduct down to 1°K. The superconducting energy gap $\Delta(T)$ of the β-W films prepared at 5×10^{-6} torr and 25 Å/min was determined by tunneling in W/B/M junctions, where B is the plasma-grown oxide barrier on W, and M stands for Sn, Pb, and Au counterelectrodes. The temperature dependence of the energy gap, $\Delta(T)/\Delta(0)$ vs T/T_c followed the BCS curve remarkably well. The ratio $2\Delta(0)/KT_c$ varied between 2.32 to 3.64 as against the BCS value of 3.53, corresponding to the variation in T_c between 3.1° to 3.3°K, respectively. The relative amounts of the α and β phases present were estimated from the tunneling experiments. The variations in T_c, $2\Delta(0)$, and $2\Delta(0)/KT_c$ are related to the relative amounts of the α and β phases present in the composite film and their connectivity. (Diss. Abstr.)

42125 SCATTERING OF ELECTRONIC EXCITATIONS BY VORTICES IN A CLEAN TYPE-II SUPERCONDUCTOR. Cleary, Robert Michael. Stanford, Calif., Stanford Univ., 1968. 111p.

Thesis.

The problem of superconducting electrons in the presence of a dilute and random array of vortices is formulated with the help of the temperature Green's function. A self-energy function is extracted from the Green's function and a singular integral equation is obtained for it. The lowest quantum of flux for a vortex, which is ch/2e, implies that a vector potential $eA/c = \hbar(2r)^{-1}$ exists in the region $r \gg \lambda(T)$ ($\lambda(T)$ is the penetration depth) where there is no magnetic field and r is the radial coordinate in a cylindrical system centered on the vortex axis. The scattering of electrons by such a curl-free vector potential was first investigated by Bohm and Aharonov. It is shown that this effect introduces spatial oscillations in the order parameter and electron density of the superconductor at large distances from the vortex axis and the modifications it imposes on the T matrix are deduced. Wave functions are calculated from the Bogolyubov equations for two models of a vortex. In a first, the order parameter and the superfluid velocity function $v_s \simeq \hbar/(2mr)$ are cut off sharply at a radius $\xi(T) = \kappa^{-1}\lambda(T)$. The order parameter is zero inside of $\xi(T)$ and superfluid velocity zero outside. This model while admittedly crude has the virtue of being exactly soluble in terms of elementary functions. In a more realistic model based on the Ginzburg–Landau theory, a WKBJ approximation on the Bogolyubov equations is solved numerically. The T matrix and the scattering cross section are obtained as functions of the energy and polar angle of the excitations with the external field. The effect of scattering by vortices on the thermal conductivity and ultrasonic attenuation is deduced starting from correlation functions. In the limit that B tends to zero, the theory may be summarized by a temperature-dependent cross section a(T) which is found to depend on the direction of heat flow or sound propagation for longitudinal waves and polarization for transverse ones. This cross section is computed numerically with T near T_c for the ultrasonic attenuation and comparison with experiment is made. (Diss. Abstr.) (TSS)

42126 MODEL OF ELECTRON BUBBLE IN SUPERFLUID HELIUM. Li, Hai Tung. Waltham, Mass., Brandeis Univ., 1968. 98p.

Thesis.

A model of an electron bubble in a superfluid is formulated. The radical and surface mode oscillations of the electron bubble are investigated, and the frequencies of these oscillations are obtained. Two different approaches are used to obtain the static deformation energy of the bubble: the first is based on a coordinate transformation formalism and the second is based on a method first developed by Rayleigh. Classical equation of motion approach is then used to study the oscillatory motion of the electron bubble. The problem of time-dependent boundary condition in quantum mechanics is examined and some illustrative examples are given. (Diss. Abstr.)

42127 THEORY OF ELECTRON–ELECTRON INTERACTION AND SUPERCONDUCTIVITY IN DILUTE MAGNETIC ALLOYS ABOVE THE KONDO TEMPERATURE. Solyom, J. (Central Research Inst. for Physics, Budapest); Zawadowski, A. Z. Phys., 226: 116-38(1969).

The effective electron–electron interaction resulting from the virtual polarization of the impurity spin is investigated. Abrikosov's pseudofermion representation of spin operators was applied. It is pointed out that the effective electron–electron interaction consists of two parts, elastic scattering and inelastic scattering. The second part shows a singularity of new type as $(\omega - \omega')^{-1}$, where $\omega - \omega'$ is the energy transfer between the two electrons. Both parts were calculated in logarithmic approximation. In spite of the fact that the second one is found to be lower by one order of the typical logarithmic Kondo terms than the first one, both terms can be of the same order of magnitude. Studying the superconducting transition temperature, Abrikosov and Gor'kov's calculation is extended to include these interactions in any order of perturbation theory keeping the leading logarithmic terms. The results are restricted to the temperature region well above the Kondo temperature. Considering the decrease of the superconducting transition temperature due to the magnetic impurities in the antiferromagnetic case, the effect of the elastic scattering can be essentially reduced by the inelastic one. (auth)

42128 ANALYSIS OF THE RESULTS OF EXPERIMENTS ON THE INTERMEDIATE STATE OF A SUPERCONDUCTING CYLINDER WITH CURRENT. Freud, R. (Inst. of Low Temperatures, Wroclaw. Dept. of Low Temperatures, Wroclaw). Acta Phys. Pol., 35: 925-37(1969).

An analysis is made of the experimentally discernible departures from the London model in a superconducting cylinder with a current which arises due to Joule heat generated in the domains of the normal phase, deformations of the superconducting domains caused by surface energy at the boundaries of the normal and superconducting phases, and shortening of the free path of conduction electrons because of scattering at the surface of the superconducting domains. It was proved that these perturbing factors can be eliminated by performing experiments with samples of sufficient purity, of sufficiently large diameters, and close enough to the critical temperature. On the basis of an analysis of the experimental material it was shown that, despite refinements, the results of experiments contradict the London theory. No analysis was made of the experiments performed with samples of small diameters (50 to 100 microns) or performed at temperatures much different than the critical temperatures. For, under these conditions, the thermal energy density due to the Joule effect is large, the superconducting domains may become deformed, a London structure cannot become fully formed, and the influence of the shortening of the free path of conduction electrons by scattering at the wire surface comes into play. (auth)

42129 BERNOULLI POTENTIALS IN SUPERCONDUCTORS. Rickayzen, G. (Univ. of Kent, Canterbury, Eng.). J. Phys., C (London), 2: 1334-7(July 1969).

A relation between the Bernoulli potential in a superconductor and the Meissner current is developed from thermodynamic arguments. The relation is used to obtain the temperature dependence of the potential. For a pure superconductor at the absolute zero the result agrees with that of Adkins and Waldram (1968). For an isotropic superconductor at a finite temperature the potential is proportional to the parameter $\partial\rho_s/\partial\rho$. (auth) (UK)

42130 RESPONSE PROPERTIES OF A BOSE LIQUID: CONNECTION BETWEEN SYMMETRY BREAKDOWN AND MICROSCOPIC DEFINITION OF THE SUPERFLUID DENSITY. de Pasquale, F. (Univ., Rome. Consiglio Nazionale delle Richerche, Rome); Tabet, E. Ann. Phys. (N. Y.), 51: 223-50 (Feb. 1, 1969).

The general response properties of a Bose liquid with condensed phase were studied, both at $T = 0°K$ and at finite temperature. This is accomplished by exploiting the gauge-invariance requirement of the current–current correlation functions $K_{\mu\nu}$ with the aid of techniques developed in previous papers. The main result obtained is an explicit microscopic construction of the superfluid density ρ_s. As an example, an approximation derived from the Bogolyubov model is explicitly worked out. Gauge and Galilei symmetry breakdowns are also discussed, showing that in an infinite-volume system with long-range correlations, the Galilei relativity principle is satisfied in a very particular way. Some results on the long-range behavior of correlation functions, first obtained by Schafroth in the special case of a free charged Bose gas, are shown to be valid also for the Bose liquid. (auth)

42131 MEASUREMENT OF TRANSITION SPEED OF JOSEPHSON JUNCTIONS. Stewart, W. C. (RCA Labs., Princeton, N. J.). Appl. Phys. Lett., 14: 392-4(June 15, 1969).

The speed of the transition between the pair tunneling state and the single-particle tunneling state of Josephson junctions is in the nanosecond region for sufficiently large junction areas and low critical currents. The transition time varies with junction capacitance and inversely with critical current. The delay is calculated to be small compared to the transition time. (auth)

42132 SUPERCONDUCTIVE TRANSITIONS OF DIFFERENT TYPE II COMPOUNDS UNDER HYDROSTATIC PRESSURE. Neubauer, H. (Univ., Giessen, Ger.). Z. Phys., 226: 211-21(1969). (In German).

An apparatus for production of hydrostatic pressure is described, which uses a mixture of n-pentane and iso-pentane and transmits pressure uniformly, still at low temperatures. The superconductive transitions of the A15(β-W type)-compounds Nb_3Sn, Nb_3Al, V_3Si and the B1(NaCl type)-compound NbN have been measured under pressure up to $18 \cdot 10^3$ kp/cm^2. The transition temperatures of the compounds V_3Si and NbN are increasing with pressure. Further measurements have been done on some selected ternary compounds, e.g., $Nb_3(Al_{1-x}Ge_x)$, to prove some predictions for the effect of pressure on superconductive transition. (auth)

42133 COHERENT STATES IN THE THEORY OF SUPERFLUIDITY. II. FLUCTUATIONS AND IRREVERSIBLE PROCESSES. Langer, J. S. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., 184: 219-29(Aug. 5, 1969).

The coherent-state formalism is used to develop a theory of fluctuations and irreversible processes in a superfluid Bose system. Equations of motion for the density matrix are derived both for the case of an isolated system and for the system in interaction with a heat bath. The formalism allows one to go easily to the classical limit and thus to obtain equations for the probability distribution of the superfluid order parameter. The results are in a form suitable for the calculation of the decay of superflow near the λ point and other similar phenomena. (auth)

42134 THE STRUCTURE OF SINGLE VORTICES IN TYPE-II SUPERCONDUCTORS. I. ASYMPTOTIC BEHAVIOR. Eilenberger, Gert (Kernforschungsanlage, Juelich, Ger. Univ., Cologne); Buettner, Helmut. Z. Phys., 224: 335-52(1969).

The first results of a program for the investigation of the detailed electronic and magnetic structure of type-II superconductors are reported. The structure of a single flux bundle or vortex in an infinite superconducting specimen is investigated, assuming weak coupling and a spherical Fermi surface of the material. The equations governing the gap parameter $\Delta(r)$ and the vector potential $A(r)$ are suitably scaled and simplified using the symmetry of the system. These equations can be solved numerically only; for their solution the asymptotics of $\Delta(r)$ and $A(r)$ far from the center of the vortex are required. These asymptotics are derived here by properly linearizing the equations; they are found to be of the type $r^{-1/2} \exp(-r/r_0)$ where r_0 is determined by temperature and material parameters. Implicit equations for r_0 are derived and discussed. It is found that for materials with κ values less than 1.7 (e.g., pure niobium) r_0 becomes complex at low temperatures; i.e., the deviation of $\Delta(r)$ and $A(r)$ from their values at infinity is a damped oscillation as function of r. (auth)

42135 MICROSCOPIC THEORY OF PHONON-QUASI-PARTICLE INTERACTIONS IN DILUTE SOLUTIONS OF ^{3}He IN SUPERFLUID ^{4}He. Saam, W. F. (Univ. of Illinois, Urbana). Ann. Phys. (N. Y.), 53: 219-38(June 15, 1969).

The amplitudes for phonon absorption and scattering by quasiparticles in dilute solutions of ^{3}He in superfluid ^{4}He are derived, at $T = 0$, from the exact microscopic theory. The results justify those obtained from the semi-phenomenological theory of quantum hydrodynamics. In addition, the exact quasi-particle scattering amplitude is shown to be equal to the zero-momentum-transfer limit of the effective potential of Bardeen, Baym, and Pines. (auth)

42136 GROUND STATE PROPERTIES OF THE DILUTE GAS MODEL OF AN INTERACTING DILUTE MIXTURE OF FERMIONS IN A BOSE GAS. Saam, W. F. (Univ. of Illinois, Urbana). Ann. Phys. (N. Y.), 53: 239-52(June 15, 1969).

In the dilute gas model the ground state energy of a dilute mixture of Fermions in a Bose gas is calculated to first order in the gas parameter and second order in the Fermion concentration. Fermi liquid parameters and forward scattering amplitudes are obtained, and the criterion for stability against a phase separation is discussed. (auth)

42137 ELECTRON–ELECTRON INTERACTION IN SUPERCONDUCTORS WITH IMPURITIES. Bergmann, G. (Univ., Goettingen, Ger.). Phys. Lett., 29A: 492-3(July 28, 1969).

A superconductor with impurities is considered where the impurities participate in the oscillation of the lattice. Scattered electrons are able to excite phonons. This mechanism increases the electron-phonon interaction. Therefore an enlarged attractive electron–electron interaction is obtained. (auth)

42138 FLUCTUATIONS IN A SUPERCONDUCTOR ABOVE T_c IN THE HIGH FIELD REGION. Usadel, K. D. (Univ., Goettingen, Ger.). Phys. Lett., 29A: 501-2(July 28, 1969).

The singular part of the electric conductivity is calculated for bulk material and for films with a static magnetic field applied. Dirty metals and high magnetic fields are considered only. (auth)

42139 ISOTOPE EFFECT IN SUPERCONDUCTORS. Rothwarf, A. (RCA Labs., Princeton, N. J.). Phys. Lett., 29A: 504-5(July 28, 1969).

The discovery of a large positive isotope effect ($T_c \sim M^\alpha$, $\alpha \approx 2$) in α-uranium has raised the question of whether a new mechanism is necessary to explain this result. It is pointed out that the usual picture of superconductivity which explains the negative isotope effect, does not hold if α exceeds 0.5 at zero pressure. Since the results on α-uranium were obtained with the material under a pressure of ~11 k bar, the possibility remains that the observed value of α is due to a pressure effect. This possibility is discussed. (M.H.R.)

42140 BULK MEAN FIELD FLUCTUATIONS IN RESISTANCE OF ARRAYS OF SUPERCONDUCTING POINT CONTACTS ABOVE T_c. Clark, T. D. (Philips Research Labs., Eindhoven, Netherlands); Tilley, D. R. Phys. Lett., 29A: 514-15(July 28, 1969).

The resistance of ball arrays increases according to the "bulk" Curie–Weiss law. The increase is attributed to fluctuations in the contact regions. (auth)

42141 INTERACTIONS BETWEEN FLUX-LINE LATTICE DEFECTS AND CRYSTAL LATTICE DEFECTS IN TYPE-II SUPERCONDUCTORS. Kusayanagi, E.; Yamafuji, K. (Kyushu Univ., Fukuoka). Phys. Lett., 29A: 529-30(July 28, 1969).

Interaction energy between an edge dislocation in a flux-line lattice and a screw dislocation in a crystal lattice is derived in the case of their parallel orientation, while such an energy is zero if both defects belong to a crystal lattice. (auth)

42142 DIAMAGNETIC SUSCEPTIBILITY OF SUPERCONDUCTING TIN ABOVE T_c. Doll, R. (Zentralinstitut fuer Tieftemperaturforschung, Munich). Phys. Lett., 29A: 534-5(July 28, 1969).

In a bulk sample of pure tin a small, but strongly temperature- and field-dependent diamagnetic susceptibility has been found, extending over a temperature range of about 30 millidegrees above the transition temperature to superconductivity. (auth)

42143 TRANSITION TEMPERATURES OF SUPERCONDUCTING ALLOYS. Buettner, H.; Gerlach, E. (Battelle-Institut e.V., Frankfurt am Main). Phys. Lett., 29A: 551(July 28, 1969).

Based on McMillan's theory of strong-coupled superconductors a simple relation between the transition temperature T_c of dilute alloys and their Debye temperature Θ is derived. (auth)

42144 INTERPRETATION OF THE JOHNSTON–KING EXPERIMENT ON EVAPORATION OF LIQUID He. Anderson, P. W. (Bell Telephone Labs., Inc., Murray Hill, N. J. Cavendish Lab., Cambridge, Eng.). Phys. Lett., 29A: 563–4(July 28, 1969).

The Johnston–King experiment on the velocity distribution of atoms evaporated from He II is interpreted in terms of elastic transmission of the single-particle component of rotons. (auth)

42145 THEORY OF THE MAGNETIZATION OF PURE TYPE-II SUPERCONDUCTORS. Brandt, U. (Univ., Hamburg). Phys. Lett., 29A: 568–9(July 28, 1969).

The magnetization M of a bulk pure type-II superconductor is calculated for magnetic fields H_a below H_{c2} and all temperatures T. Comparison is made with experimental data in Nb. In the limit $T = 0$ and H_a near H_{c2} the magnetization has the nonanalytic form $M \propto [H_{c2}-H_a]/\ln[(H_{c2}-H_a)/H_{c2}]$. (auth)

42146 AN ENERGY BAND MODEL OF Nb- AND Ta- DICHALCOGENIDE SUPERCONDUCTORS. van Maaren, M. H.; Harland, H. B. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett., 29A: 571–3(July 28, 1969).

An energy band model for Nb- and Ta-dichalcogenide superconductors is proposed, based on experimental data of Hall effect and specific heat measurements. The results indicate an overlapping valence- and d-band system. (auth)

42147 EFFECT OF PRESSURE ON T_c AND BAND STRUCTURE IN TRANSITION METAL ALLOYS. Gey, W.; Koehnlein, D. (Univ., Karlsruhe, Ger.). Phys. Lett., 29A: 450–1(June 30, 1969).

Measurements on ten alloys of the series Zr–Nb–Mo show a close correlation of dT_c/dp with the d-band structure of these alloys and suggest that the d band is virtually rigid with respect to pressure. (auth)

42148 DYNAMICAL SCALING LAWS AND TIME-DEPENDENT LANDAU–GINZBURG EQUATION. Di Castro, C. (Univ., Rome); Ferro-Luzzi, F.; Tyson, J. A. Phys. Lett., 29A: 458–9(June 30, 1969).

It is shown that a self-consistent version of the time-dependent Landau–Ginzburg theory yields results in agreement with scaling. (auth)

42149 ZERO-FIELD RESONANCES IN OXIDE JOSEPHSON JUNCTIONS. Matisoo, J. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Lett., 29A: 473–4(June 30, 1969).

The observation of step-structure in the dc I–V curve of an oxide Josephson junction in zero magnetic field is reported. The structure results from the excitation of cavity resonances by barrier inhomogeneities. The junctions in question are $Sn-SnO_x-Sn$ and the barrier inhomogeneities are whiskers or dendrites extending through the oxide. (TSS)

42150 NOTE ON LARMOR'S THEOREM AS APPLIED TO THE ROTATING SUPERCONDUCTOR. Alben, R. (Yale Univ., New Haven). Phys. Lett., 29A: 477–8(June 30, 1969).

Larmor's theorem may be used to show an equivalence between a stationary superconductor and a rotating system in which the field is everywhere ω/γ greater. The equivalence applies to the fundamental form of the Hamiltonian and the factor γ is $-e/2m_0c$ where all parameters refer to the free electron. (auth)

42151 ON DISLOCATIONS IN THE FLUXON LATTICE: SOME ATOMIC CALCULATIONS. Hill, D. C.; Morrison, D. D.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 29A: 482–3(June 30, 1969).

The calculations described in this letter result in dislocations having the actually observed configurations, but show that dislocations are not stable without pinning, and that the two types observed have the same energy but slightly different Peierls "wells." (auth)

42152 SUPERCONDUCTING LABORATORY SOLENOID OF 112 KILOERSTEDS MADE OF WIRE OF DEFORMED ALLOYS. Lazarev, B. G.; Lazareva, L. S.; Golik, V. R.; Goridov, S. I. (Technical Physics Inst., Kiev). Dokl. Akad. Nauk SSSR, 184: 89–90(Jan. 1, 1969). (In Russian).

A ternary alloy (close to 50 Nb–25 Zr–25 Ti), and a binary alloy (Nb–60 Ti) were studied in detail as superconductors. Critical magnetic fields of wires of these alloys at 4.2 and 2°K were 78 and 99 kOe for the ternary alloy, and 108 and 127 kOe for the binary alloy. A study of the critical current as a function of the field led to the creation of a compact solenoid with a field strength of 112 kOe. The solenoid consisted of three sections having diameters of the working openings of 5 mm, 72 mm and 122 mm. The inner section was wound with wire of the binary alloy which had the highest critical field. The two outer sections were wound with wire of the ternary alloy which had a lesser critical field, but a higher current density. The critical currents, and the corresponding maximum fields are given separately for each of the sections. One external section creates a field of 40 kOe in a working space having a diameter of 122 mm. The solenoid without its inner sections creates a field of about 70 kOe in a space having a diameter of 72 mm. It is possible to obtain a field of 138 kOe in a gap of about 1 mm by using a ferromagnetic insert of dysprosium. The total weight of the solenoid was 14 kg. The metal cryostat for the solenoid has an inner diameter of 200 mm and a height of 1.3 m. The equipment requires 15 to 20 liters of liquid helium. (TTT)

42153 MAGNETIC-FIELD-INDUCED SURFACE QUANTUM STATES IN SUPERCONDUCTING INDIUM. Maldonado, Juan Ramon. College Park, Md., Univ. of Maryland, 1968. 103p.

Thesis.

When a magnetic field is applied parallel to the surface of a type-I superconductor, surface states are induced within the penetration depth of the applied field. These states lie inside the superconducting energy gap and for $T \neq 0$ are occupied by thermally excited quasiparticles. Transitions from these states into the BCS continuum, due to absorption of microwave photons by the quasiparticles, give rise to sharp peaks in the derivative of the resistive component of the surface impedance (dR/dH) as a function of H. Those peaks were observed in dR/dH in superconducting indium, tin and lead. The amplitude of the peaks was found to decrease with decreasing temperature. The peak position H_p was observed to vary with temperature as the reciprocal of the penetration depth $\lambda(T)$ calculated from the BCS theory. At a constant temperature, H_p was observed to increase linearly with frequency from 10 to 40 GHz. At the low frequency end the present observations were compared with earlier experimental work where the peaks were not resolved. The anisotropy of the peak position was studied with the applied magnetic field in several symmetry planes. The results were compared with the known Fermi surface model for indium. The amplitude and the line width of the peaks in dR/dH was also studied as a function of surface conditions in indium and tin. The peak position H_p was observed to shift to higher fields with increasing surface roughness. This result was attributed to the increase of the kinetic energy of the skipping electrons perpendicular to the surface due to the scattering at the surface. In the normal state there exist very similar magnetic-field-induced surface states that give rise to oscillations of the surface impedance at low magnetic fields. A preliminary study of the temperature dependence of the amplitude and the line width of the normal state oscillations in gallium and bismuth was performed. From this study information was obtained on the temperature dependence of the relaxation time $\tau(T)$. (Diss. Abstr.)

42154 MICROWAVE SURFACE IMPEDANCE OF METALS IN WEAK MAGNETIC FIELD. (NORMAL STATE AND SUPERCONDUCTING STATE). Kuo, Chen-chi. College Park, Md., Univ. of Maryland, 1967. 102p.

Thesis.

The microwave surface impedance of several metals in a magnetic field below about 100 Oe was studied experimentally. The samples were made from high-purity single crystals. The range of the microwave frequency is 28 Gc to 60 Gc. In their normal state the samples of tin, indium, and aluminum show oscillatory variations in the power absorption with respect to H, magnetic field, in the range 0 to 100 Oe. From the orientation dependence and the frequency scaling of the maxima of the resistance derivative peaks these were identified as members of several series. An explanation of the normal-state weak magnetic field effects of the microwave surface impedance was obtained. In this explanation, the peaks of the derivative of the surface resistance are attributed to transitions between magnetic-field-induced surface states of the electrons as proposed by Nee and Prange recently. Other properties of the low-field effects are intimately related to the geometry of the electron Fermi surface of the metals. There is much evidence indicating that the signal is due to electrons on the cylindrical sections of Fermi surface. The experiments were extended to the superconducting state of tin and indium. The surface resistance derivative is measured as a function of magnetic field. By reducing the temperature to a certain point below the transition temperature T_c, pronounced positive peaks were observed on the dR/dH vs H tracings. These anomalies are always followed by a decreasing dR/dH. There is no relation between the critical field H_c and the fields of the peak anomalies. The superconducting-state absorption derivative peaks are also dependent on the relative orientations of the symmetry axis, the magnetic field and the microwave polarization, the symmetry planes, and the surface conditions. They are also functions of the microwave frequencies. It was found that the fields of the anomalies are directly proportional to the microwave frequency in the frequency range from 28 to 60 Gc. The similarities of the dependences of the signals of the two states on the microwave polarization, the symmetry planes, and the surface conditions suggest that the similar explanations in the normal state can also be applied to the superconducting state, i.e., the dR/dH peaks are due to transitions between magnetic-field-induced surface states in the superconductors. Such states have been considered by Pincus. (Diss. Abstr.)

42155 VORTEX MOTIONS IN IDEAL BOSE SUPERFLUID. Cooper, Martin J. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., 73A: 309-12(May-June 1969).

A general nonlinear field equation is derived for the macroscopic order parameter of an ideal coherent Bose gas. It is shown that this noninteracting system can support stable quantized vortex-like motions within the superfluid phase. It is suggested that this coherent phase of the ideal Bose gas describes the dominant physical features of real superfluid liquid helium. (auth)

42156 THEORY OF TRANSITIONS FROM LARGE TO NEARLY-SMALL POLARONS, WITH APPLICATION TO Zr-DOPED SUPERCONDUCTING $SrTiO_3$. Eagles, D. M. (Electronics Research Center, Cambridge, Mass.). Phys. Rev., 181: 1278-90(May 15, 1969).

Expressions for the matrix elements of the Hamiltonian and overlap integrals between large-polaron and nearly small-polaron states are given in terms of various large- and nearly small-polaron parameters. The dependence of the mass of the ground state on the bare-electron mass in a region of transition between large- and nearly small-polaron states is found. Parameters of the theory are evaluated using the continuum–polarization model of electron–phonon interactions. Modifications due to anisotropy and the presence of many longitudinal polar modes of lattice vibration are discussed briefly. Making use of a recent analysis by Reik of free-carrier optical-absorption results in $SrTiO_3$ using small-polaron theory, it is shown that the rate of mass rise deducible from superconductivity data on Zr-doped $SrTiO_3$ can be explained by the theory if the bare transverse mass m_{bt} is taken to be $m_{bt} \simeq 0.6m_e$, where m_e is the free-electron mass, and if small-polaron binding energies are assumed to be larger by a factor of about 1.4 than their values in the continuum-polarization model. The dependence on Zr concentration of the ratio of phonon-induced to Coulomb-intervalley electron–electron interactions deducible from the superconductivity data is discussed within the framework of the model. (auth)

42157 COEXISTENCE OF FERROMAGNETISM AND SUPERCONDUCTIVITY. Avenhaus, R.; Fischer, Oe.; Giovannini, B.; Peter, M. (Univ., Geneva). Helv. Phys. Acta, 42: 649-62 (July 1, 1969).

Some aspects of the problem of coexistence of superconductivity and ferromagnetism are analyzed, in particular the suggestion of Jaccarino and Peter (Phys. Rev. Lett., 9: 290(1962)), that it might be possible to compensate an exchange field by an external magnetic field, such as making superconductivity possible in a range of very high magnetic fields. The Meissner effect will however, in principle, impede very high magnetic fields from penetrating the material. This paper examines whether there are interactions, acting on the orbits of the electrons, that could play the role of effective magnetic fields, and therefore "compensate" the Meissner effect. It is shown that, within the assumptions, this is not possible. (auth)

42158 PROPERTIES OF δ-GALLIUM SUPERCONDUCTORS. Bosio, Louis; Cortes, Robert; Defrain, Andre; Epelboin, Israeel (CNRS, Paris). Compt. Rend., Ser. B, 268: 1314-16(May 19, 1969). (In French).

Magnetization cycles are determined for a new metastable phase of gallium, from which an attempt is made to identify with δ Ga. The behavior of this superconductor, characterized by a critical temperature equal to 7.85 ± 0.15°K and a critical field of 815 ± 30 Oe at 0°K, differs from that of other known superconducting phases. (tr-auth)

42159 STABILIZED COMPOSITE SUPERCONDUCTORS AND MAGNETS. Doi, Toshio; Kudo, Mitsuhiro (Hitachi Ltd., Tokyo). Hitachi Hyoron, 51: No. 2, 1-4(Feb. 1969). (In Japanese).

In order to develop a large superconducting magnet for MHD power generators or bubble chambers and the superconducting materials to be used in the magnet, four wires of Nb–40 Zr–10 Ti, 0.25 mm in diameter, and ten of the same wires were arranged in parallel each in imbedding material of high-purity copper. The stabilized composite superconductor HISUPER-4X obtained was wound in the superconducting coils and the HISUPER-10X in the superconducting solenoid. Each coil was subjected to the coil test in liquid helium; and an evaluation of their practical use was obtained. From the results, the superconducting magnet was found to be operable in a stable manner. Based on the data, the world's largest superconducting magnet of 45 kG, 380-mm ID, employing the HISUPER-10X strip, is being constructed at present. (NSA of Japan)

42160 THERMAL CONDUCTIVITY OF TYPE-II SUPERCONDUCTORS NEAR THE UPPER CRITICAL FIELD. Delvecchio, Leonard Vincent. New Brunswick, N. J., Rutgers–The State Univ., 1968. 116p.

Thesis.

The thermal conductivity of a number of In–Bi specimens was measured as a function of magnetic field and temperature between .3°K and 4.2°K. The specimens had sufficient Bi concentration to make them type-II superconductors. The thermal conductivity was measured in the mixed state, primarily, near the upper critical field, H_{c2}. In this region the electronic thermal conductivity is expected to increase linearly with magnetic field, with a slope which has been calculated by Caroli and Cyrot. The experimental results are in very good agreement with the theory above a reduced temperature of 0.4. Below that temperature the experimental values of the slope are lower than the theoretical values by up to 30%. It is possible to account for this discrepancy by assuming a more rapid variation with temperature of the parameter κ_3/κ than that which is theoretically expected. For the comparison with theory it was necessary to separate the electronic and lattice conductivities, and to analyze the lattice term into its contributions from the various scattering mechanisms. A correction could then be made for the field variation of the lattice conductivity. From the temperature variation of the upper critical field and the residual electrical resistivity, ρ_0, a number of parameters could be determined which are characteristic of dilute solutions of bismuth in indium and presumably of pure indium also. They are the product of the electronic mean free path, ℓ, and the residual electrical resistivity, the product of D, the diffusion constant and the residual electrical resistivity, and the superconducting coherence length ξ_0. The values found were $\rho_0\ell = .55 \pm .05 \times 10^{-11}\ \Omega\ cm^2$, $D\rho_0 = 1.5 \pm .1 \times 10^{-4}\ \Omega\ cm^3/sec$, and $\xi_0 = 2900 \pm 200$ Å. (Diss. Abstr.)

42161 CALORIMETRIC STUDY OF NIOBIUM IN THE SUPERCONDUCTING, MIXED, AND NORMAL STATES. Ferreira da Silva, Jose. Leiden, Univ. of Leiden, 1967.

Thesis.

Type-II superconductivity is described and a brief survey of the theory is presented, together with the thermodynamic relations used in the analysis of the data. The experimental method is described and the results are presented, discussed, and compared with theory. A comparison is made between the field dependence of the magnetocaloric effect, specific heat, and isothermal magnetization, at the same temperature. (M.H.R.)

42162 PROCEEDINGS OF THE CONFERENCE ON FLUCTUATIONS IN SUPERCONDUCTORS, PACIFIC GROVE, CALIFORNIA, MARCH 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968. 392p. (CONF-680320).

Thirty papers and two abstracts are included. Separate abstracts were prepared for twenty-nine papers. One paper was abstracted previously as NSA 23: 5335. (M.H.R.)

For abstracts of individual papers see: 42163–42191.

42163 INTRODUCTION TO THE GENERAL THEORY OF THERMODYNAMIC FLUCTUATIONS. Ferrell, Richard A. (Univ. of Maryland, College Park). pp 3-46 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

This review begins with the most intuitive and concrete example of fluctuations, that of Brownian motion, and progresses to the general case of thermodynamic fluctuations of an extended system. How the fluctuations can be studied by explicitly dealing with the Langevin forces, or alternatively by making use of the fluctuation–dissipation theorem, is demonstrated. A derivation of the latter, entirely within the realm of classical physics, is presented. This method reduces the problem of fluctuations to that of determining the frequency and wave number dependent conductivity function. It is discussed that it is generally necessary, for the determination of the fluctuations of all of the thermodynamic variables, to supplement the fluctuation–dissipation conductivity formula by additional fluctuation–dissipation formulas. However, for the density fluctuations the conductivity formula suffices because of the continuity equation which expresses a conservation law rigorously relating the density and velocity fluctuations. (M.H.R.)

42164 THERMODYNAMIC FLUCTUATIONS IN SUPERCONDUCTORS. Burgess, Ronald E. (Univ. of British Columbia,

Canada). pp 47-82 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

Some of the basic relations governing electromagnetic and order-parameter fluctuations in relatively simple situations are considered. The Ginzburg–Landau model is used and the results are deemed to be reasonably valid in the vicinity of T_c. The subjects covered are: fluctuations in a superconducting ring, fluctuations of magnetic moment, coupled superconductors, a superconducting ring with a weak link, fluctuations of the order parameter, and fluctuations of a persistent current. (M.H.R.)

42165 SUPERCONDUCTIVITY IN NARROW CHANNELS. Langer, J. S. (Carnegie-Mellon Univ., Pittsburgh). pp 83-99 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

A phenomenological theory of the onset of resistance in very narrow superconducting channels is presented. The main features of the work are presented, and some of its implications are commented on. Some recent attempts to provide a more rigorous basis for the phenomenological model are mentioned. (M.H.R.)

42166 OBSERVATIONS OF THE SPONTANEOUS TRANSITION OF A SUPERCONDUCTING RING BETWEEN STATES OF DIFFERENT FLUX QUANTA. Lukens, J. E.; Goodkind, J. M. (Univ. of California, San Diego, La Jolla). pp 101-2 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

It was observed that a superconducting tin ring ($^3/_{16}$" diameter) with zero average current undergoes apparently spontaneous transitions between states in which the magnetic flux linking the ring differs by integral multiples of a flux quantum. Measurements were made of the rate at which these transitions occur as a function of temperature and of the critical current of the ring. All measurements were made by observing the flux linking the ring which is inductively coupled to a quantum flux detector through a superconducting transformer. There are no leads attached to the ring. The transformer is outside a copper can that encloses the ring, which is temperature-regulated to 10^{-5}°K during a measurement. (M.H.R.)

42167 QUASI-PARTICLE AND COLLECTIVE EXCITATIONS. Scalapino, D. J. (Univ. of Pennsylvania, Philadelphia). pp 103-20 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

The physical quantities whose fluctuations are of experimental interest are one or two particle variables such as the current or energy density. The nature of the power spectrum of these fluctuations therefore depends directly on the quasi-particle scattering and collective states of the system. Attention is focused on the spectral properties of these excitations and their relation to fluctuations in superconductors. (M.H.R.)

42168 LINEWIDTH OF JOSEPHSON RADIATION. Parker, W. H. (Univ. of California, Irvine). pp 121-35 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

Recent observations of the linewidth of the radiation emitted by a Josephson superconducting tunnel junction are described. It is found that for both Sn/I/Sn and Pb/I/Pb Josephson junctions biased to radiate at 10^{10} Hz, the linewidth of the emitted radiation depends on the dynamic resistance of the junction at the bias voltage and the temperature. At low temperature and dynamic resistance, the linewidth is often less than the 1 kHg resolution of the detector implying a spectral purity of better than 1 part in 10^7. At temperatures greater than $T/T_c = 0.8$ the linewidth begins to increase rapidly with temperature until at $T/T_c = 0.98$, the linewidth has reached 10 MHz. (M.H.R.)

42169 OBSERVATION OF THE JOSEPHSON PLASMA OSCILLATION. Dahm, A. J. (Univ. of Pennsylvania, Philadelphia). pp 137-40 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

A superconducting tunnel junction operating in the dc Josephson mode can support a plasma-like oscillation of pairs across the junction at a frequency $\omega_J = [2eI_1\overline{\cos\varphi}/hC]^{1/2}$. Here I_1 is the critical dc Josephson current, $\overline{\cos\varphi}$ is the average value of the cosine of the phase difference across the junction and C is the junction capacitance. For $\overline{\cos\varphi} = 1$, ω_J is typically of order 10 GHz. It can be lowered by (1) increasing the dc Josephson current, (2) applying an external magnetic field, or (3) increasing T towards T_C. This resonance has been observed by two techniques. In the small-signal limit, the second-harmonic rf voltage generated by the junction was plotted as a function of dc current. Resonances were observed when ω_J was equal to the fundamental frequency of the microwaves irradiating the junction or to the second harmonic of this frequency emitted from the junction. The plasma frequency is observed to have the temperature and magnetic-field dependence predicted by theory. The Q of the resonance was on the order of 100 and decreased with increasing temperature. A simpler experimental technique was used in the large-signal limit. In this technique, the resonance was observed by plotting the dc Josephson current as a function of rf voltage. The increase in rf voltage in the junction at resonance causes singularities in the Josephson current–rf voltage plane. This plasma oscillation involves an exchange of energy between the electric field across the barrier and the coupling energy of the system. The plasma frequency is obtained from the Hamiltonian for the system with external circuit included. It is shown that the independent variable representing the external circuit is the phase and not the current. (auth)

42170 FLUCTUATIONS IN ONE- AND TWO-DIMENSIONAL SUPERCONDUCTORS. Parks, R. D. (Univ. of Rochester, N. Y.). pp 141-58 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

The experimental and data analysis problems associated with the recently reported experiments on fluctuations in superconducting microbridges and whiskers are discussed in detail. One qualitative result from these experiments is the observation that the superconducting transition temperature T_c of a "one-dimensional" superconducting geometry (defined as one with two dimensions comparable to or smaller than the temperature-dependent coherence length $\xi(T)$) is lower than that of a macroscopic sample of the same material. This reduction in T_c (called ΔT_c) has been attributed to statistical fluctuations. More detailed questions concern the temperature dependence of the critical current and the dependence of ΔT_c on sample parameters. Some "two-dimensional" studies are commented on. (M.H.R.)

42171 DETERMINATION OF T_c FROM RESISTANCE MEASUREMENTS. Webb, W. W. (Cornell Univ., Ithaca, N. Y.). pp 159-61 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13-15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

The problems involved in identifying the mean field critical current curve and the critical temperature in the absence of fluctuations by using critical current data at temperatures far enough from T_c that fluctuation effects are negligible are identified. The possibilities for errors are dealt with at length. (M.H.R.)

42172 VORTEX MODES IN TYPE-II SUPERCONDUCTORS. Fetter, Alexander L. (Stanford Univ., Calif.). pp 163-5 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

In the mixed state of a Type-II superconductor, a regular array of quantized flux lines penetrates the sample. This periodic structure can support a great variety of oscillatory modes, corresponding to waves propagating at arbitrary angles with respect to the applied magnetic field. Although a completely unified treatment is not possible at present, a simple description is given in two distinct limiting cases: (1) for an extreme Type-II superconductor ($\kappa \gg 1$) in low and intermediate fields ($H_{c1} \leq H \ll H_{c2}$), where the magnitude of the order parameter is constant almost everywhere, and the London theory becomes appropriate, and (2) in high fields ($H \lesssim H_{c2}$), the magnitude of the order parameter $|\Delta|$ is reduced relative to its value Δ_0 in zero field, so that the ratio $|\Delta|/\Delta_0$ serves as an expansion parameter. (M.H.R.)

42173 PHASE FLUCTUATIONS IN SUPERCONDUCTORS. Eck, R. E.; Nisenoff, M.; Ulrich, B. T.; Mercereau, J. E. (Ford Scientific Research Staff, Newport Beach, Calif.). pp 167-89 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Several experiments are described that show the effect of dissipation or fluctuation in a process that is normally considered to be entirely superconducting. These experiments are all based on an equation relating the time rate of change of relative phase to the relative free energy. In the first experiment the phase is driven, generating a potential difference. In the second experiment a difference in potential is established and phase precession occurs. In the third situation the superconductor is undriven and allowed to fluctuate. (M.H.R.)

42174 FLUX FLOW NOISE. Chilton, Frank (Stanford Research Inst., Menlo Park, Calif.). pp 193-207 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

The properties of flux flow and flux flow noise are reviewed. The distinction between stochastic and deterministic noise is recalled. The kinetic and thermodynamic models of flux flow are discussed. The experimental results are presented. (M.H.R.)

42175 FLUX TRANSPORT NOISE IN SUPERCONDUCTORS. van Gurp, G. J.; van Ooijen, D. J. (Philips Research Labs., Eindhoven, Netherlands). pp 209-25 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Topics covered include: flux flow noise, flux modulation noise, and flicker noise in Type-II superconductors; flux flow noise in Type-I superconductors; and magnetization noise in hollow cylinders. (M.H.R.)

42176 FLUX JUMPING IN TYPE-II SUPERCONDUCTORS. Rochlin, G. I. (Univ. of California, Berkeley). pp 227-30 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

The distribution of bundle sizes was measured for flux bundles entering long thin cylinders of Pb−2 at.% In alloys (K ~ 1.2) in a slowly varying axial magnetic field at 4.2°K. (M.H.R.)

42177 GENERAL EXPRESSION FOR THE POWER SPECTRUM OF STOCHASTIC PULSE SEQUENCES WITH APPLICATION TO NOISE IN TYPE-II SUPERCONDUCTORS. Heiden, Cristoph (Univ. of California, Berkeley). pp 231-8 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Some results are presented that were obtained in connection with the measurement of power spectra of flux jumps, which were produced by magnetizing a Type-II superconductor in a linearly varying magnetic field. An alloy of Pb−2 at. % In was used for the specimens, which were cylindrical in form. The flux jumps produced voltage pulses in a small pickup coil surrounding the specimen and the power spectrum of these voltage pulses was measured. The peculiar behavior of these spectra led to a new study of the power spectra of stochastic pulse sequences. (M.H.R.)

42178 FLUCTUATIONS AND THE APPROACH TO THE SUPERCONDUCTING TRANSITION FROM ABOVE: PARACONDUCTIVITY AND THE CRITICAL REGION. Ferrell, Richard A. (Univ. of Maryland, College Park). pp 239-49 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Some general considerations were presented previously in an attempt to express in more detail the qualitative observation that a short electron mean-free path will tend to make more evident the effect of fluctuations on the behavior of a superconductor near its phase transition. A calculation is described here which introduces fluctuations into the Ginzburg−Landau theory and which leads to conclusions which differ quantitatively from those of Ferrell and Schmidt [Phys. Lett., 25A: 544(1967)]. (M.H.R.)

42179 FLUCTUATIONS IN NARROW THIN-FILM SUPERCONDUCTORS. Hunt, T. K. (Ford Motor Co., Dearborn, Mich.). pp 251-4 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Without constructing a detailed model of the fluctuations leading to a decoupling of the quantum phases across a small link it is shown that the simple assumption that the smallest possible "elemental link" goes into the "normal" state under the influence of the fluctuations, can account for all the reported observations of depressed transition temperatures in narrow samples. In the experimental work low resistance helium temperature shunts were used to effectively eliminate the extraneous noise. When this precaution is taken, the experimental data show excellent agreement with the results of the simple analysis proposed in which no parameters need to be adjusted. (M.H.R.)

42180 SUPERFLUIDITY AND LONG-RANGE ORDER IN TWO-DIMENSIONAL SYSTEMS. Lasher, Gordon (IBM Watson Research Center, Yorktown Heights, N. Y.). pp 255-7 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Brief arguments are presented for the existence of superfluidity and superconductivity in two-dimensional systems. (M.H.R.)

42181 "NOISE" ON CONSTANT CURRENT STEPS IN ALUMINUM MICROBRIDGES. Rochlin, G. I. (Univ. of California, Berkeley). pp 261-3 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Some observations of "noise" on the I−V characteristics of thin film microbridges in the resistive region near the superconducting transition are reported. These were performed on the dirtiest possible system, aluminum microbridges deposited at ~10 Å/sec at 10^{-6} torr. The following observations were made: External reactances do not shift the switching frequency. As the samples are immersed in liquid helium well below the lambda point, nucleate boiling seems unlikely. The steps and the spectra are reproducible after cycling to 77°K. The steps are observed in a wide variety of experimental situations. (M.H.R.)

42182 COLLECTIVE OSCILLATIONS IN A JOSEPHSON JUNCTION. Stephen, M. J. (Massachusetts Inst. of Tech., Cambridge). pp 265-75 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

The electric and magnetic properties of junctions much larger than the Josephson penetration depth are discussed. The propagation of waves in these structures is discussed, and the effect of thermal fluctuations on various properties is considered. (M.H.R.)

42183 MAGNETIC FIELD DEPENDENCE OF THE CRITICAL CURRENT IN A SELF-FIELD LIMITED JUNCTION. Clarke, John (Univ. of California, Berkeley). pp 285-6 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

An experimental result is shown which verifies the theory of Owen and Scalapino [Phys. Rev., 164: 538(1967)] for the magnetic field dependence of the critical current of a junction that is self-field limited. The junctions were prepared by evaporating successively onto a glass slide a strip of lead, a circle of copper, and a cross-strip of lead so that the oxide barrier of the conventional Josephson junction was replaced by a copper film. (M.H.R.)

42184 COMMENT ON JUNCTIONS WITH METALLIC BARRIERS. Baratoff, Alexis (Brown Univ., Providence). pp 287-9 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.

See CONF-680320.

Experiments have shown that both insulating junctions and metallic "point" contacts exhibit a Josephson-like dc current-phase characteristic. The results of an attempt to understand when a contact behaves as indicated are discussed. The following extreme situation was studied: a superconductor containing a region of thickness with an increased impurity content and, hence, reduced coherence length. One-dimensional solutions of the Ginzburg–Landau equations were investigated ignoring Meissner screening. (M.H.R.)

42185 EFFECTS OF FLUCTUATIONS ON JUNCTION CHARACTERISTICS. Vant-Hull, L. (Ford Scientific Staff, Newport Beach, Calif.). pp 291-302 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

The case of two superconductors coupled by the tunneling of electrons is considered. It is shown that there is a lower limit to the value of the pair tunneling current which can be observed in a given apparatus, determined by the amount of incoherent energy incident on the junction from all sources. It is pointed out how averaging due to noise currents can round off I–V curves making the zero voltage currents unobservable. An experimental arrangement is discussed that involves double junctions, where the geometry of the sample makes the effects of the Josephson currents inherently visible in the face of overwhelming fluctuations—a 1.3-meter interferometer. (M.H.R.)

42186 DYNAMICS OF PHASE FLUCTUATIONS IN WEAKLY CONNECTED SUPERCONDUCTORS. Zimmerman, James E. (Philco-Ford Corp., Newport Beach, Calif.). pp 303-4 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

How voltage (and therefore phase) fluctuations appear in a weakly connected superconductor is considered as a consequence of electromagnetic contact with its environment. It is assumed that the superconductor is in thermal equilibrium with its environment. (M.H.R.)

42187 CRITICAL PHENOMENA AND THEIR BEARING ON THE SUPERCONDUCTING TRANSITION. Hohenberg, P. C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 305-37 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

The various quantitative criteria which have been proposed for the breakdown of mean-field theory are reviewed, and an attempt is made to determine which ones might lead to observable effects. Second-order phase transitions and the contrast between "classical" and "critical" behavior are reviewed briefly. In describing the criteria for the breakdown of mean-field theory, equilibrium and transport properties are treated separately. A few remarks on available experimental data are included. (M.H.R.)

42188 CRITICAL PHENOMENA IN SUPERFLUIDS. Josephson, B. D. (Cambridge Univ., Eng.). pp 339-42 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

Quantities that can be measured in superfluids are the ones associated with the transport of matter and heat. Further results concerning the behavior of superfluids near T_c may be obtained by extending scaling-law ideas to dynamic phenomena. A number of results obtained by studying the behavior of entropy fluctuations as one passes through the critical point are discussed. (M.H.R.)

42189 CRITICAL-POINT FLUCTUATIONS IN SUPERFLUIDS. Tyson, J. A. (Univ. of Chicago). pp 343-54 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

Some experiments using second sound that show the validity of the hydrodynamic approximation in the macroscopic critical region are described. An attempt to push the experiments closer to the border $k\xi = 1$, yielding information about ξ_0 and the form of the correlation function in this intermediate region is described. (M.H.R.)

42190 DECAY OF PERSISTENT CURRENTS IN SUPERFLUID HELIUM. Reppy, John D. (Cornell Univ., Ithaca, N. Y.). pp 355-6 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

An experiment in progress at Cornell to investigate the existence of the predicted decay in persistent currents in superfluid helium is described. Logarithmic decay was observed for a number of persistent currents formed in an annular container filled with a 500-Å pore filter material. The results imply that the free energy barrier separating superfluid flow states remains finite in the neighborhood of the transition. (M.H.R.)

42191 DECAY OF SUPERFLOW IN HELIUM. Fisher, Michael E. (Cornell Univ., Ithaca, N. Y.). pp 357-80 of Proceedings of the Conference on Fluctuations in Superconductors, Pacific Grove, California, March 13–15, 1968. Goree, William S.; Chilton, Frank (eds.). Menlo Park, Calif., Stanford Research Institute, 1968.
See CONF-680320.

A tentative discussion of the time dependence of the superfluid flow is presented, from a fairly general theoretical viewpoint. The logarithmic dependence on time is seen to follow from the basic kinetic equation governing the change of the mean superfluid velocity. The significance of the observations for the nature of the activation step are discussed. The kinetic equation is derived and solved in terms of the fundamental barrier function $r(v_s)$ and other parameters. The nature of the fluctuation step is discussed generally to obtain the magnitude of the change in v_s associated with each step; this leads to agreement with the observed decay rates. The driving free energy is estimated and shown to be effectively infinite in most circumstances as assumed in the preceding analysis. The barrier free energy and, thence, the critical velocity v_c are estimated. The predicted dependence of v_c on temperature is in agreement with observation but the predicted magnitude is too large by a factor of order 5. Possible reasons for this discrepancy are considered briefly, and a calculation is made that allows for microscopic nonuniformities in the flow. These might explain the differences by allowing the dominant fluctuations to occur in local regions of above-average velocity. The conclusions are summarized briefly. (M.H.R.)

42192 SUPERCONDUCTING METALS IN POROUS GLASS AS GRANULAR SUPERCONDUCTORS. Hindley, N. K.; Watson, J. H. P. (Corning Glass Works, Corning, N. Y.). Phys. Rev., 183: 525-8(July 10, 1969).

The critical fields of superconductors in porous glass are found to have the same temperature dependence as the critical field of a homogeneous dirty alloy. An effective mean free path for electrons in the normal state can be deduced; it is proportional to the pore diameter but is much smaller. This is most easily explained if the superconductor consists of grains separated by tunneling barriers, for this gives a mean free path equal to the grain size multiplied by an average of the transmission coefficient of the barriers. This model can also give a plausible explanation of the large change in critical field produced by chemical treatment of the glass before impregnation with metal. Parmenter's theory of granular superconductors shows that vortices can exist in such materials, and the critical current should be determined by vortex pinning. The measured critical current for indium in porous glass is less than that calculated from a Parmenter formula which assumes that the fields in the sample are uniform. (auth)

42193 EFFECT OF A MAGNETIC FIELD ON PHOTON ABSORPTION IN SUPERCONDUCTING ZINC FOR PHOTON ENERGIES UP TO 1.8 TIMES THE ENERGY GAP. Garfunkel, M. P.; Hays, D.; Spalding, M. (Univ. of Pittsburgh). Phys. Rev., 183: 501-3(July 10, 1969).

The magnetic field dependence of the microwave absorptivity of superconducting zinc has been measured up to 90 GHz at $t = T/T_c = 0.476$ ($T_c = 0.840°K$). This corresponds to a photon energy of 3.6Δ. The effect of the static magnetic field on the absorption is found to change sign at a photon energy of about 2.5Δ, in agreement with a recent theory. (auth)

42194 FLUX PENETRATION IN AN ANISOTROPIC TYPE-II SUPERCONDUCTOR. Dorer, Gary L.; Boemmel, Hans E. (Univ. of California, Los Angeles). Contract 4-444024-21922. Phys. Rev., 183: 528-32(July 10, 1969).

Calculations are presented for the magnetic induction B and the free energy of an anisotropic type-II superconductor near its upper critical field H_{c2}. It is shown that this field is not necessarily parallel to the externally applied magnetic field H, its direction depending on the direction of H relative to the principal axes of the Ginsburg effective-mass tensor. These results suggest that torque measurements, made on geometrically symmetrical samples, should be useful in determining the upper critical field H_{c2} as well as the components of the effective-mass tensor. (auth)

42195 INTERNAL FLUX MOTION IN LARGE JOSEPHSON JUNCTIONS. Scott, A. C.; Johnson, W. J. (Univ. of Wisconsin, Madison). Appl. Phys. Lett., 14: 316-18(May 15, 1969).

A "displaced linear branch" has been observed in the volt-ampere characteristics of square (1 × 1-mm) $Sn/O_x/Sn$ and $Pb/O_x/Pb$ Josephson junctions. The slope of the linear branch is independent of magnetic field and of temperature below 2.2°K. It is suggested that this effect can be attributed to internal flux motion. (auth)

42196 SUPERCONDUCTING TUNNELING EFFECTS IN THE MIXED STATE OF Nb. Tsuda, Nobuo (Tokyo Univ.). Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A, No. 359, 25p (June 1969).

Superconducting tunneling effects in the mixed state of Nb, whose $H_{c2}(O) = 4450$ Oe, were observed using the usual oxidization techniques. Results are rather well explained by the theory of Brandt et al. with the assumption of diffuse boundary scattering, if $\Delta \cdot \Lambda/\hbar \cdot v_f$ is replaced by $\Delta \cdot \Lambda/\hbar \cdot v_f \cdot \alpha$, where α is an arbitrary parameter. (NSA of Japan)

42197 ENTROPY OF THE MIXED STATE OF SOME LOW-κ TYPE-II SUPERCONDUCTORS. Hopkins, D. C.; Rice, R. R.; Carter, J. M.; Hayes, J. D. (Univ. of Missouri, Rolla). Phys. Rev., 183: 516-24(July 10, 1969).

The entropy of the mixed state of type-II superconductors with low $\kappa(\sim 1)$ is studied for the alloys $Pb_{0.96}Tl_{0.04}$ and $In_{0.88}Sn_{0.12}$. The current theories are reviewed for approximations valid near H_{c1} and near H_{c2}. The experiments show for the most reversible sample ($Pb_{0.96}Tl_{0.04}$) that $(\partial S/\partial B)_T$ of the mixed state depends only on temperature, and that $(\partial S/\partial T)_B$ increases linearly with B from its value for the superconducting state until it drops discontinuously to its normal state value at H_{c2}. There is no abrupt increase in the specific heat at constant magnetic induction near H_{c1} as is observed in the specific heat at constant applied magnetic field. A method of determining the thermodynamic critical field of an irreversible sample without assuming a parabolic form is discussed and applied to the data. The thermodynamic critical field determined in this way is used to calculate κ_1 and κ_2. The parameters are very nearly equal for $Pb_{0.96}Tl_{0.04}$ with a temperature dependence of $(1 + t^2)^{-½}$. Measurements of $(\partial S/\partial B)_T$ are also reported on the type-I superconductors Sn and Pb. The conclusion, as expected, is that $(\partial S/\partial B)_T$ in the intermediate state depends on the temperature only. (auth)

42198 TRANSPORT PROPERTIES OF DIRTY TYPE-II SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS. Lowell, J.; Munoz, J. S.; Sousa, J. B. (Oxford Univ.). Phys. Rev., 183: 497-500(July 10, 1969).

The thermal and electrical conductivities and the Nernst and Ettinghausen coefficients of two alloys of Nb with Mo have been measured over a range of temperature in the region of magnetic field close to H_{c2}. All these coefficients vary linearly with field in this region as expected on the basis of current ideas as to the nature of the excitation spectrum. The slope at H_{c2} agrees fairly well with the relevant theories, although some discrepancies remain unexplained. (auth)

42199 SURFACE IMPEDANCE IN NONLOCAL THEORY. Zepp, Gerard (Laboratoire de Physique Theorique, Puy-de-Dome, France). Compt. Rend., Ser. B, 268: 1389-92(May 28, 1969). (In French).

The value of the impedance and the surface resistance of a variable field of a semi-infinite superconductor having a large coherence length is studied. Taking into account the nonlocal form of the normal and superconducting currents, approximate theoretical formulas are deduced in several particular cases, permitting the surface resistance to be determined. (tr-auth)

42200 EFFECT OF PRESSURE ON THE SUPERCONDUCTING STATE PARAMETERS. Rajput, J. S. (Banaras Hindu Univ., India); Gupta, Ashok Kumar. Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 18-22(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

A method is presented for theoretical calculation of the logarithmic volume derivatives of the three superconducting state parameters: the phonon interaction parameter, the Coulomb pseudopotential, and the energy renormalization parameter. Calculations were made for Pb and Al. (M.C.G.)

42201 MEASUREMENTS OF THE LIFETIME OF EXCITATIONS IN SUPERCONDUCTING ALUMINIUM. Gray, K. E.; Long, A. R.; Adkins, C. J. (Royal Society Mond Lab., Cambridge, Eng.). Phil. Mag., 20: 273-8(Aug. 1969).

The lifetime of excitations in superconducting aluminum was measured by two entirely different techniques. Several factors affecting the measured lifetimes are identified and an analysis of the experimental results shows them to be in agreement with theoretically calculated lifetimes. (auth) (UK)

42202 PERSISTENT CURRENTS INDUCED IN THE SUPERCONDUCTING SURFACE SHEATH. Park, J. G. (Imperial Coll. of Science and Tech., London). Advan. Phys., 18: 103-56(Mar. 1969).

The magnetization curves of Type-II superconductors, and Type-I superconductors for which $H_{c3} > H_c$, show a hysteretic tail in a range of field below H_{c3} which corresponds to a persistent current induced in the superconducting surface layer (the sheath). Existing theories of this magnetization M are based on the hypotheses (a) that departures of the current distribution from uniformity are confined to the ends and may be neglected for sufficiently long cylinders, and (b) that at the persistent ("critical") current the free energy has the same value as in the normal state. These are the essential assumptions of what is called the infinite cylinder model. The apparent differences between the results of calculations based on this model made by Fink et al., (1965) and those made by Park, (1964, 1965, 1967) are shown to reside in a parameter η which Fink et al. assume to be ~1. Values of η for a number of values of field and Ginzburg–Landau parameter κ are given. In a certain range $\eta \sim 1$ but η deviates markedly from 1 when κ is large ($\eta \propto \kappa^{½}$ then), and at low fields when κ is small. It is shown that according to the model the tail should be symmetrical about the $M = 0$ axis, but that in order to show that it should be so, from free energy arguments, one must take into account the magnetization m of the sheath itself (due to its internal currents) even though m makes a negligible contribution to the total magnetic moment. The theory is compared with experiment, and significant discrepancies are found, particularly in the field dependence of M near H_{c3}, which cannot be explained as being the result of imperfections in specimen quality. (auth) (UK)

42203 QUASIPARTICLE–VORTEX SCATTERING IN SUPERFLUID HELIUM. Titus, William James. Stanford, Calif., Stanford Univ., 1968. 124p.

Thesis.

The scattering of quasi particles (phonons, rotons, and He^3 impurities) from a quantized, rectilinear vortex in superfluid helium was investigated through the use of the Lippmann–Schwinger equations of quantum mechanics. The prime assumption in this formalism is that a quasi particle behaves like a stable point particle with a well-defined energy–momentum dispersion relation and that the vortex velocity $\underset{\sim}{v}_s$ has translational and rotational invariance along and about the z axis of some cylindrical coordinate system (r, φ, z). The main disadvantage in using the Lippmann–Schwinger formalism is the need to assume some form for the scattering potential which acts between a quasi particle with momentum $\underset{\sim}{P}$ and energy E(P) and a vortex with velocity $\underset{\sim}{v}_s$. For phonons and rotons, this interaction was taken to be a symmetrized $\underset{\sim}{v}_s \cdot \underset{\sim}{P}$; this is simply the added energy a quasi particle has in a system in which the superfluid is moving with a slowly varying velocity $\underset{\sim}{v}_s$. For impurities, both a symmetrized $\underset{\sim}{v}_s \cdot \underset{\sim}{P}$ interaction and an interaction suggested by Bardeen, Baym, and Pines were considered. With the preceding interactions, the quasi particle-vortex scattering was investigated using the Lippmann–Schwinger equations. For impurities having a quadratic energy spectrum, a differential equation for the spatial wave function can be obtained from the Lippmann–Schwinger equations; this is not true for phonons and rotons because of the peculiar form of their energy spectrum. In the latter case, the scattering can be studied by solving certain integral equations for the partial wave T and R matrices. For the case in which core effects of the vortex are negligible, these integral equations may be reduced to a Green's function type of differential equation, yielding approximate solutions for rotons and phonons. The results for phonons and rotons are found to be in essential agreement with those previously calculated by other individuals, using a variety of methods. However, there is one important difference. In order for the results of roton-vortex scattering to agree with second sound experiments, it appears that a $-\underset{\sim}{v}_s \cdot \underset{\sim}{P}$ interaction should be used. This is not consistent with phonon–vortex scattering, where a $+\underset{\sim}{v}_s \cdot \underset{\sim}{P}$ interaction is needed to produce results which agree with those calculated by other individuals. This may indicate that the point particle assumption for rotons is incorrect. When core effects are negligible, the differential equation method for the T and R matrices can also be applied to impurity–vortex scattering. In this case, the scattering results are exact, although they require that for certain low partial waves the impurity is completely captured by the vortex. This capture assumption can be avoided by choosing the core velocity of the vortex to differ from its classical 1/r behavior. A core which rotates like a solid body and a core which acts like a repulsive barrier were considered. The scattering in the presence of a vortex core was treated by using the differential equation for the spatial wave function. In comparing the results with data from vortex ring experiments, it was found that the best agreement occurred for the rotating core model, a $\underline{v}_s \cdot \underline{P}$ interaction, a core radius of 0.45 Å, and an effective impurity mass equaling 2.8 He^3 masses. The results derived for the Bardeen, Baym, Pines interaction did not agree with the experimental data. However, the amount of experimental data available is limited. It would be beneficial to carry out vortex ring experiments over a broader range of temperature and impurity concentration, and second sound experiments with He^3 impurities present. (Diss. Abstr.)

42204 PRESSURE ACTIVATED SUPERFLUID VALVE. Kreitman, Marshall (Univ. of Dayton, Ohio). Rev. Sci. Instrum., 40: 1249-50(Sept. 1969).

When carrying out investigations on materials at low temperatures it is often desirable to have equipment which can change the sample temperature over a range which includes liquid helium and nitrogen temperatures. This need has been met in part by Dewars which are constructed with cold fingers on which heaters and thermometers, necessary for temperature control, have been mounted. The cold finger is frequently connected to a liquid helium reservoir via a volume which can contain either an amount of liquid or gaseous helium depending on the cooling capacity or the range of operating temperature desired. The volume receives liquid helium from the reservoir by passage through a valve. However, in certain usages, it is inconvenient or undesirable to suspend a mechanical linkage or other valve operating mechanism within the cryostat. This would be particularly true when using glass Dewar systems which are designed to be detachable from a top flange. At such times useful applications may be made of pressure activated values. A pressure activated superleak valve has been designed and used to pass quantities of liquid helium from a reservoir to a cold finger. The constructional and operational features of the superleak valve are described. (B.G.D.)

42205 ULTRASONIC ATTENUATION IN PURE AND IMPURE SINGLE CRYSTALS OF SUPERCONDUCTING TIN. Chaudhuri, K. D.; Jain, M. C. (Univ. of Delhi). Cryogenics, 9: 235-41(Aug. 1969).

Ultrasonic attenuation in single crystals of superconducting tin is affected by the presence of strain and impurities. The effect of different pulse amplitudes on attenuation in pure and impure single crystals was studied for strained and annealed specimens. It was found that, at different amplitudes, oscillations are always present in an impure specimen, but in a pure specimen, small amplitudes favour oscillation. The temperature-dependent attenuation is also strongly dependent on the strain content of the specimen and the amplitude. (auth) (UK)

42206 SUPERCONDUCTIVE COMPOSITES: HEAT TRANSFER AND STEADY STATE STABILIZATION. Maddock, B. J.; James, G. B.; Norris, W. T. (Central Electricity Research Labs., Leatherhead, Eng.). Cryogenics, 9: 261-73(Aug. 1969).

A scheme is presented which allows the steady-state stabilization of a superconductive composite to be easily determined for any heat transfer or heat generation condition. In particular, it is shown how the recovery currents of composite conductors can be found using the observed heat transfer to boiling helium. Current-voltage characteristics may also be derived. The effects of surface coatings and of the thickness of the superconductive strands are shown and some corrections to earlier work on this thickness effect are given. (auth) (UK)

42207 TECHNIQUES FOR MEASURING SOUND PROPAGATION IN LIQUID ^4He AND ^3He–^4He SOLUTIONS. Abraham, B. M.; Eckstein, Y.; Ketterson, J. B.; Vignos, J. (Argonne National Lab., Ill.). Cryogenics, 9: 274-80(Aug. 1969).

The description of an instrument for the accurate measurement of ultrasonic attenuation and velocity in liquid ^4He and ^3He–^4He solutions, and the details of the cell in which the measurements were made, are presented. Measurements were made by matching the amplitude of a signal traversing the helium to a reference pulse of equal amplitude but opposite phase (both signals being derived from the same oscillator). By observing the change with temperature in the amplitude and phase of the signal passing through the helium, both the change in the velocity and in the attenuation could be determined. The cell in which the measurements were made employed two matched x-cut quartz crystal transducers, separated by a fused quartz spacer. The crystals, which were clamped only at the rim, were loaded on both sides by liquid helium. (auth) (UK)

42208 PRECISE COMPARISON OF THE JOSEPHSON FREQUENCY–VOLTAGE RELATION AT MICROWAVE AND FAR-INFRARED FREQUENCIES. Finnegan, T. F.; Denenstein, A.; Langenberg, D. N.; McMenamin, J. C.; Novoseller, D. E.; Cheng, L. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 23: 229-33(Aug. 4, 1969).

The Josephson frequency–voltage relation has been compared at frequencies of 9.48 and 891 GHz using radiation-induced steps. The results indicate that the relation is frequency independent over this range within an uncertainty of approximately 1.5 ppM. (auth)

42209 SUPERCONDUCTING MATERIALS FOR DEVICES SPANNING THE INFARED–MICROWAVE GAP. Rose, K. (Rensselaer Polytechnic Inst., Troy, N. Y.). Cryogenics, 9: 227-30(Aug. 1969).

The superconductive state is described in terms of the energy gap which separates the superfluid ground state from excited states. The concept of the energy gap limits the types of devices possible. It is directly related to the critical frequency, temperature, current, and magnetic field for transitions from the superconducting to the normal state. The influence of all these effects on possible applications is considered in turn. In general, while there appear to be promising possibilities for the use of superconducting devices in the infrared–microwave gap, much remains to be done to improve their yield, reliability, and packaging. (UK)

42210 CRYOELECTROTECHNICS OF THE CENTRE DE RECHERCHES DE LA COMPAGNIE GENERALE D'ELECTRICITE. Dubois, Pierre. Entropie, No. 26, 15-29(Mar.-Apr. 1969). (In French).

A comprehensive survey of results obtained in the field of cryoelectrotechnics is presented as follows: research and development on superconducting magnets, study of electric motors with superconducting inductor, research and development on energy storage coils and superconducting switches likely to be associated with them, test of an aluminum cable model the temperature of which is held between 20° and 30°K, theoretical studies relating to the performances of superconducting materials in direct current or alternating current, study of superconducting materials in thin sheets for special applications, or as superconducting materials of second generation, and development of a superconducting material "Alustable" fabricated from niobium–titanium or niobium–zirconium aluminum stabilized wires. (auth)

42211 ANCHORING OF FLUX LINES BY THE SURFACES OF SUPERCONDUCTORS. Maldy, Jacques. Entropie, No. 26, 52-6(Mar.-Apr. 1969). (In French).

The main results are presented of research done in order to obtain superconducting materials able to bear without loss higher and higher current densities. It is demonstrated that in the presence of a magnetic field and a current, the contribution of the surfaces at anchoring of the field lines makes it possible to obtain critical current densities above 10^6 A/cm^2. These results obtained with thin films, seen to be transposable to thin wires. (auth)

42212 A CALCULATION OF THE QUASI-PARTICLE RECOMBINATION RATE IN SUPERCONDUCTING ALUMINIUM. Gray, K. E. (Royal Society Mond Lab., Cambridge, Eng.). Phil. Mag., 20: 267-72(Aug. 1969).

Details of the Fermi surface are taken into account in determining the rate due to umklapp processes, which is found to be approximately equal to the rate due to normal processes. At low temperatures in bulk aluminium ($\Delta_0 = 0.176$ MeV) the recombination rate is 9.45×10^{-12} N(T) sec^{-1}, where N(T) is the quasiparticle density per cm^3 at the temperature T. (auth) (UK)

42213 CRITICAL CURRENTS IN NIOBIUM–TANTALUM SUPERCONDUCTING ALLOYS. Langlade, P. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France); Renard, M. Cryogenics, 9: 231-4(Aug. 1969).

The critical currents of superconducting niobium–tantalum alloys were measured as a function of applied magnetic field and temperature for specimens in the form of a ribbon. The specimens had been tempered in ultrahigh vacuum at high temperature to eliminate the majority of defects. The results show that the critical current increases with decreasing Ginzburg–Landau parameter K. This effect can be explained by statistical fluctuations in the concentration of the alloys. (auth) (UK)

42214 MEASUREMENTS OF PLASTIC FLOW IN SUPERCONDUCTORS AND THE ELECTRON-DISLOCATION INTERACTION. Alers, G. A.; Buck, O.; Tittmann, B. R. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev. Lett., 23: 290-3(Aug. 11, 1969).

The increase in flow stress which occurs at the transition from the superconducting to the normal state has been measured as a function of work hardening, strain rate, and temperature in specimens of pure lead and indium. The results show that this flow-stress increase is strain-rate independent and proportional to $1-(T/T_c)^2$ to an accuracy of ±5%. The lack of strain-rate dependence is inconsistent with the simple model which relates the flow stress to the viscous drag force required to move a dislocation through an electron gas. (auth)

42215 OSMOTIC PRESSURE OF DEGENERATE ^3He–^4He MIXTURES. Landau, J.; Tough, J. T.; Brubaker, N. R.; Edwards, D. O. (Ohio State Univ., Columbus). Phys. Rev. Lett., 23: 283-6(Aug. 11, 1969).

The osmotic pressure of $^3He-^4He$ mixtures has been measured down to 0.027°K. The results are used (a) to check the validity of the $^3He-^3He$ effective interaction deduced from transport data using recent exact solutions of the Boltzmann transport equation, (b) to obtain the limiting solubility of ^3He in ^4He as a function of pressure, and (c) to demonstrate the metastability of supersaturated mixtures of ^3He in ^4He in the absence of a free surface. (auth)

42216 THEORETICAL DETERMINATION OF SURFACE THICKNESS OF LIQUID ^4He AND ^3He. *Fitts, D. D. (Univ. of Pennsylvania, Philadelphia). Physica, 42: 205-12(Apr. 21, 1969).

The quantum statistical-mechanical theory of surface tension is applied to liquid ^4He and to liquid ^3He at 1.4°K. This theory relates the surface tension of the thickness of the region between the liquid and vapor phases. By a comparison of the calculated surface tension as a function of interfacial thickness with the experimental value, the surface thickness of liquid ^4He is found to be 4 to 5 molecular diameters and that of liquid ^3He 7 to 8 molecular diameters. (auth)

42217 COMMENTS ON THE EFFICIENCY OF FLUX PUMPING INTO SUPERCONDUCTING CIRCUITS. Van Beelen, H.; De Langen, M.; Kerkdijk, C. B. W. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 42: 265-76(Apr. 21, 1969).

The efficiency of flux pumping by means of the transport of flux through a superconducting pumping bridge into a superconducting circuit is studied. It is found that the pumping characteristics are well presented by the relation: $H_L = H_{sat}(1-e^{-\eta z})$ in which H_L is the field generated in the superconducting coil and z the number of pumping strokes. The parameters H_{sat} and η are studied as a function of the pumping velocity, the pumping field, and the material used as a pumping bridge. As any change of flux in the superconducting circuit must correspond to an actual flow of flux through the pumping bridge, the reduction of the pumping efficiency is ascribed to a flux loss opposing the pumping action, due to three different mechanisms: the Meissner effect, leading to a constant loss ϕ_M, reducing the pumping flux ϕ_p; the eddy current loss, which in good approximation is found to be given by the factor $(1-e^{-\beta v})$, in which β is a material constant determined by the normal-state conductivity and v the velocity of the pumping magnet; a loss $-\eta\phi_L$, originating from the interaction of the current, generated in the circuit, with the flux-containing moving region (ϕ_L is the flux generated in the circuit). For pumping fields well above the thermodynamic critical field H_c η appears to be approximately proportional to the flux contained by the resistive region. This leads to an absolute maximum for H_{sat} obtainable with a given system. (auth)

42218 ORIGIN OF SUPERCONDUCTIVITY. II. Krebs, H. (Univ., Stuttgart). Z. Naturforsch., 24a: 848-50(May 1969). (In German).

The assumption that superconductivity can occur if the electrons can move without crossing atomic nodal surfaces is confirmed by some more examples. In compounds as $CuRh_2S_4$ (spinel structure) and CuS_2 (pyrite structure) per formula unit one s electron is missing to a stable electron configuration. The high-pressure modifications of Se and Te possess one 5s or one 6s electron per atom. InC_8K, LiBi, and NaBi p_z orbitals of C or Bi and s orbitals of the alkali atoms form layers without nodal surfaces. In the hexagonal and tetragonal tungsten bronzes there exist channels containing molecular orbitals without nodal surfaces. In the cases mentioned last the superconductivity is expected to be highly anisotropic. (auth)

Plasma and Thermonuclear Physics

42219 PLASMA PHYSICS INDEX. Bibliography, Author Index, Subject Index. Volume 4, No. 6, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 276p.

577 articles on various aspects of plasma physics are listed. (M.O.W.)

42220 VVEDENIE V FIZIKU PLAZMY. (Introduction to Plasma Physics). Chernetskii, A. V. Moscow, Atomizdat, 1969. 304p.

The principal aspects of processes in plasma considering the motion of non-interacting charged particles, their fluxes, and motions with collisions and other interactions are briefly reviewed. Various forms of gas discharges, gas discharge plasmas, and various methods for describing processes in plasmas are discussed. Macroscopic plasma characteristics, concepts of transport processes, diffusion and penetrability are analyzed as well as oscillations and waves in plasma and instabilities. Plasma flow in transverse and longitudinal magnetic fields, plasma in electric and magnetic fields and plasma clusters are covered in the last chapter. (51 references are included) (R.V.J.)

42221 PLASMA PHYSICS: TECHNOLOGY INDEX. VOLUME 3, NO. 6. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main, Ger., Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 130p.

A listing is presented of 280 articles on various aspects of plasma physics. Subject and author indexes are included. (M.O.W.)

Confinement and Heating

Refer also to abstracts 42268 and 42289.

42222 (CU-3958-2) TURBULENT HEATING STUDIED BY MICROWAVE SCATTERING. Wharton, C. B.; Prono, D. S.; Sandel, F. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). May 1, 1969. Contract AT(30-1)-3958. 5p. (CONF-690803-15). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

The plasma is generated in two pulsed conical pinch guns and injected simultaneously into each end of a static 2:1 magnetic mirror field of 0.22 Tesla. The initial density is $n_e = 10^{19}$ m^{-3} at an ion temperature Ti ≈ 10 eV. Turbulent heating is produced by applying an 80 KV pulse between two electrodes 150 cm apart, so that 3000 to 5000 amperes flow along the magnetic field for ~0.8 μsec. A current-driven instability results, producing strong turbulence. While the plasma is turbulent, its resistivity is anomalously high and the plasma column expands radially at a rapid rate. A spectrum of plasma waves is formed, having strong peaks at certain frequencies. After the heating pulse one finds that the ions have gained ~500 eV of perpendicular energy, and the plasma is confined in the magnetic mirrors. The turbulence spectrum during the heating pulse was studied by microwave scattering at wavelengths of 7.5 and 4.8 mm. The main conclusions are that angularly dependent scattering was seen, with amplitude peaks at frequencies encompassing the ion cyclotron frequency, the ion plasma frequency, the electron plasma frequency and other frequencies whose significance is not yet clear. (auth)

42223 (MATT-681) THE USE OF A STIX COIL FOR ION CYCLOTRON RESONANCE HEATING IN A NON-UNIFORM MAGNETIC FIELD. Sinclair, R. M.; Rothman, M. A.; Hosea, J. C. (Princeton Univ., N. J. Plasma Physics Lab.). Apr. 1969. Contract AT(30-1)-1238. 8p. Dep. CFSTI.

Ion cyclotron resonance heating in the Model C stellarator is limited at high power levels by the rapid decrease in plasma density under the induction coil, and the narrow range of density over which significant energy can be coupled to ion cyclotron waves. In an effort to couple more energy to the plasma, the normally constant confining field was modified to vary linearly by ≤30% over the length of the coil. Although it was possible to couple energy to the plasma over a somewhat broader range of density in the nonuniform field, no improvement in heating efficiency or plasma temperature was achieved compared with that obtained with the uniform field. (auth)

42224 (NP-17974) ELECTRON CONTAINMENT IN A CUSPED GEOMETRY. Rijnhuizen Report 69-53. Strijland, W. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). May 1969. 90p. Dep.

Thesis. Submitted to Univ. of Utrecht, Netherlands.

The accumulation of charged particles in a cusp magnetic field is studied. The magnetic configuration satisfies the conditions for magnetohydrodynamic stability, but the zero field point in the center makes the particle motion highly nonadiabatic. An experiment with electrons is compared with computer-calculated orbits and with theory on the average behavior of the particles. For the latter, it was assumed that the field consists of a central region which is fully randomizing and mirror regions where the magnetic moment is conserved. The electron experiment is partly a scale model of a large ion experiment and offers easy manageability because of the low electric and magnetic field strengths. Reasonable consistency among the several approaches is acquired. The containment of the electrons was prolonged by closure of the mirror leaks with electrostatic fields. The containment was found to be limited only by collisions on the background neutrals. Numerical results are in accordance with a derivation that takes into account the geometry of the magnetic field and the particle density distribution. The field was made more adiabatic by removing the low-field region with an azimuthal field generated by an axial conductor. The resulting minimum-B configuration, a "stuffed cusp," fulfills the condition for magnetohydrodynamic stability over a large region. An auxiliary mechanism for capture was found to be necessary, for which electron-cyclotron resonance was used. Also in this case the containment is collision-dominated and is in accordance with theory. (auth)

42225 (UCRL-71733) NUMERICAL CALCULATIONS OF PLASMA HEATING BY MEANS OF SUBNANOSECOND LASER PULSES. Shearer, J. W.; Barnes, W. S. (California Univ., Livermore. Lawrence Radiation Lab.). May 26, 1969. 48p. (CONF-690622-1). Dep. CFSTI.

From Laser Interaction and Related Plasma Phenomena Meeting, East Windsor Hill, Conn.

Numerical computer techniques have been used to calculate plasma heating by means of focused subnanosecond pulses at the neodymium laser wavelength. The plasma is treated as a single fluid in the hydrodynamic equations, but the electrons and ions may be at different temperatures. Thermal diffusion, electron-ion interaction, and free-free radiation emission are included. The linear equation for the absorption of laser light is derived from the free-free equation, and its properties are shown to lead to the consequence that a laser-produced plasma should be described by a "coronal" type of equation of state. The calculation technique is applied to various experimental situations, including the recent lithium deuteride thick target neutron detection experiments, and the results are presented. (auth)

42226 THEORY OF STOCHASTIC HEATING OF PARTICLES IN MAGNETIC MIRROR SYSTEMS. Krlin, L. (Inst. of Plasma Physics, Prague). pp 74-9 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The action of a hf stochastic field on particles contained in a magnetic mirror system was studied. The rf field is assumed to be excited by an external source and to penetrate from one side through the mirror to only those locations in which the rf field is in resonance with the cyclotron frequency. The field is further assumed to have a specified correlation and to be unaffected by changes in the particle distribution function brought about by heating. (M.O.W.)

42227 MATCHING TECHNIQUE TO INJECT MICROWAVE POWER INTO HIGH-DENSITY PLASMAS. Takeda, Susumu; Kameda, Shozaburo; Minami, Kazuo (Nagoya Univ., Japan). Jap. J. Appl. Phys., 8: 966(July 1969).

A dielectric plate of ¼-wavelength thickness is proposed for injecting effectively microwave power into high-density plasmas. An experimental arrangement is described. (M.O.W.)

42228 THE EXISTENCE OF THE FIELD MINIMUM LINE WITH ARBITRARY CURVATURE AND TORSION. Sometani, Taro; Yamamoto, Kenzo (Nagoya Univ., Japan). Jap. J. Appl. Phys., 8: 780-2(June 1969).

In the light of plasma containment by means of a magnetic well containing closed flux surfaces, the existence of the vacuum field minimum line with arbitrary curvature and torsion is shown. An orthogonal curvilinear coordinate system related to a nonplanar curve is used for calculating field components. It is shown that the existence of such field minimum is possible at least with a class of vacuum fields. (auth)

42229 TOROIDAL TURBULENT HEATING IN PLASMA BETATRON. Hamada, Yasuzi (Tokyo Univ.). Jap. J. Appl. Phys., 8: 957(July 1969).

An experiment is reported in which an energetic plasma of 10^{16} eV/cm^3 was obtained by toroidal turbulent heating. The apparatus was an axial-field plasma betatron having a rotation angle of 30°. Probe measurements are reported. (M.O.W.)

42230 PLASMA CAPTURE INTO A DIVERTOR APERTURE AS ASYNCHRONOUS INJECTION OF TWO PLASMA STREAMS. Zykov, V. G.; Karpukhin, V. I.; Rudnev, N. I.; Tolok, V. T. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 962-8(June 1969). (In Russian).

Some experiments on plasma capture into a divertor aperture are described. The plasmas produced by two coaxial guns were injected asynchronously through magnetic slits of the divertor. The plasma injected from the first gun formed a cylinder near the divertor surface. The influence of the plasma cylinder density on penetration of the plasma from the second gun into the aperture was studied in the region of the magnetic field of 3 to 18 kOe. This influence is shown to be very essential at plasma densities exceeding 10^{13} cm^{-3}. The decrease in the plasma cylinder density facilitates penetration of the plasma from the second gun into the aperture. (auth)

Diagnostics

Refer also to abstract 42279.

42231 (INR-1027) THEORY OF THE POPULATION OF EXCITED LEVELS AND IONIZATION EQUILIBRIUM FOR NON-THERMAL PLASMA. Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). 1969. 160p. Dep.

The influence of differences in the cross sections and on the differences in the calculated population densities for excited levels and in the degree of nonthermal plasma ionization was investigated. Calculations were performed for Maxwellian velocity distribution electrons, characterized by the electron temperature T_e. Electron temperature and density measurements from relative line intensities are described. (M.O.W.)

42232 (IPP-1/95) MEASUREMENT OF THOMSON AND RAYLEIGH SCATTERING IN A PREIONIZED Z-PINCH. Roehr, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Feb. 1969. 17p. (In German). Dep. CFSTI (U. S. Sales Only).

A 90° scattering experiment with a preionization z-pinch is described. The first part describes conventional measurements of the electron temperature and density (Thomson scattering). In the second part of the experiment Rayleigh scattering from excited hydrogen atoms was observed during very early phases of the discharge. This observation is possible because the Rayleigh scattering cross section of hydrogen atoms in the second and third quantum states is very large because of the small difference in the energy of the photons of Hα (6563 Å) and the light of a ruby laser (6943 Å). Spectral resolution of this part of the scattered light yields a minimum value for the ion temperature. (auth)

42233 (MATT-Trans-87) MEASURING THE PLASMA ENERGY IN THE TOKAMAK-3 DEVICE. Smirnov, S. V. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated for Princeton Univ., N. J., from a Russian report. 46p. Dep. CFSTI.

The transverse component of the energy ($E_\perp$) was determined by the magnitude of the diamagnetic effect of the plasma, and the longitudinal component ($E_{||}$), by the magnitude of the equilibrium shift of the plasma column. It was shown that within the limits of accuracy of the experiment it is possible to consider $E = E_\perp + E_{||} = \frac{3}{2} E_\perp$. Thus, the problem of determining E was reduced to the problem of determining $E_\perp$. The diamagnetic flux corresponding to the proposed value of $E_\perp$ was measured against a background of paramagnetic and quasiconstant magnetic fluxes exceeding it by 10 and 10^4 times. This situation imposed very strict requirements on the measuring scheme making detailed analysis of its elements and performance of additional calibration experiments necessary. The accuracy of the measurements was estimated, and the values of E obtained are presented as functions of the discharge parameters. (auth)

42234 (NP-17977) PROBE INTERFEROMETER MEASUREMENT OF ELECTRON DENSITY DISTRIBUTION IN A DECAYING HYDROGEN PLASMA. Brand, G. F.; Heckenberg, N. R. (Sydney Univ. (Australia). School of Physics). Mar. 1969. 11p. (ER-43). Dep.

A simple system capable of measuring directly the electron density profile across a plasma was developed and used to investigate the afterglow of a hydrogen plasma. The circuit consists of three ordinary-wave interferometers. The probe interferometer operates at 35 GHz over a variable path length. (M.O.W.)

42235 (ORNL-TM-2656) MULTIPLE PSEUDOWAVES PRODUCED BY A SINGLE VOLTAGE PULSE. Alexeff, I.; Jones, W. D.; Widner, M. (Oak Ridge National Lab., Tenn.). July 22, 1969. Contract W-7405-eng-26. 18p. Dep. CFSTI.

A multiple pseudowave— or a series of fast ion bursts— is generated when a short negative voltage pulse is placed on a transparent grid immersed in a plasma. The phenomenon resembles, but is not, a damped wave train. It is shown, using a single-particle model, that multiple pseudowaves can be explained in terms of ions trapped and oscillating in the ion sheath formed around the grid by the negative voltage pulse. A pulsed grid used in this manner constitutes a simple diagnostic technique for measuring plasma density. (auth)

42236 (UCRL-50638) USE OF A NEUTRAL HELIUM BEAM IN PLASMA DIAGNOSTICS. Lieberman, M. A. (California Univ., Livermore. Lawrence Radiation Lab.). July 7, 1969. Contract W-7405-eng-48. 23p. Dep. CFSTI.

The use of a neutral helium beam to diagnose the electron temperature and density of the 2X plasma is proposed. The temperatures and densities of interest probably lie in the ranges $T_e \approx 75$ to 1000 eV and $n_e \approx 1 \times 10^{12}$ to 5×10^{13} cm^{-3}. In the proposed experiment, a neutral helium beam is passed through the plasma. The plasma electrons excite neutral helium, producing optical radiation. The electron density n_e and temperature T_e can be determined by absolute and relative measurements of the optical intensities of selected spectral lines. Good spatial and time resolution can be achieved in these measurements. (auth)

42237 TRANSITION FROM THE QUADRATIC TO THE LINEAR STARK EFFECT FOR SPECTRAL LINES OF THE CESIUM ATOM. CALCULATION OF THE SPLITTING OF ENERGY LEVELS. Elyashevich, M. A.; Tkacheva, V. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 26: 1-3(Jan. 1969).

Translated from Opt. Spektrosk., 26: 3-8(Jan. 1969).

The splitting of the cesium atom energy levels with main quantum numbers n = 5, 6, and 7 was calculated as a function of the intensity of the external electric field, using the perturbation method. Hartree-Fock matrix elements were used in the calculations. In the transition region, the energy of interaction of an atom with an electric field of intensity E is comparable to the distance between neighboring levels with the same principal quantum numbers but different azimuthal quantum numbers. The interaction matrix $V = -eEr$ is obtained, where r is the radius vector of the outer electron. With the aid of this matrix, secular equations are constructed for finding the energy eigenvalues and the corresponding wave functions. The equations are solved by successive diagonalization. (auth)

42238 A LASER-EXCITED OPTICAL RESONATOR FOR ELECTRON DENSITY MEASUREMENTS ON A Z-PINCH PLASMA. Medley, Sidney Sylvester. Vancouver, B. C., Univ. of British Columbia, 1968.

Thesis.

A technique which employs a laser-excited optical resonator has been developed to measure the electron density distribution, both temporal and spatial, in the collapse stage of a fast Z-pinch discharge. The resonator device has an experimentally determined time resolution of better than 0.05 μsec and is suitable for measuring electron densities in excess of $5 \times 10^{16}/L\lambda$ cm^{-3}, where L is the length of the plasma in cm and λ is the wavelength of the laser in microns. A novel feature of this instrument is the use of an unstable optical resonator. The technique is applied to a discharge in argon at filling pressures of 100 and 1000μ Hg. The temporal and radial electron density distributions obtained exhibit several interesting features which are discussed from the point of view of the collapse process. (Diss. Abstr.)

42239 ELECTRON AND ION BROADENING OF THE HELIUM SPECTRAL LINES λ4471 AND λ4026. Gieske, Harry Anthony. College Park, Univ. of Maryland, 1968. 81p.

Thesis.

Radiation emitted by a hot, partially ionized plasma is indicative of the conditions within the plasma. The energy levels of the constituent atoms are perturbed by the microelectric fields of the ions and electrons so that the emitted spectral lines are broadened by the Stark effect. The Stark profiles of the 2^3P-4^3L, L = 1,2,3 and the 2^3P-5^3L, L = 0,1,2,3,4 transitions have been calculated for a range of electron densities between 10^{15} and 10^{18}/cm^3 and for temperatures between 5,000 and 40,000°K. The quasi-static approximation was used for ion effects and a generalized impact approximation was used to describe the electron effects. Tabulated profiles are presented which include the fine structure of the lower state. Error estimates show that the profiles are accurate to about 10%. (Diss. Abstr.)

42240 VARIATION OF THE R.F. RESPONSE OF A LANGMUIR PROBE WITH AMPLITUDE AND FREQUENCY. Smy, P. R.; Nation, J. A.; Simpson, D. (Central Electricity Research Labs., Leatherhead, Eng.). J. Phys., D (London), 2: 1095-1106 (Aug. 1969).

The rf response of a double Langmuir probe immersed in a laboratory plasma was measured over a wide range of signal amplitude, signal frequency, and plasma electron density. A theory is developed which predicts (in direct contradiction to the theory of other workers) a decrease in the probe sheath capacitance with increasing frequency in the neighbourhood of the ion plasma frequency, and a probe response above this frequency which, at high amplitudes, obeys a current ∝ $(\text{voltage})^{1/4}$ dependence. While no significant change of capacity with frequency was observed, possibly owing to experimental limitations, the high-amplitude results were in good agreement with theory and showed the appropriate current ∝ $(\text{voltage})^{1/4}$ dependence. This is in contrast to earlier step waveform (i.e. low-frequency) measurements which showed a current ∝ $(\text{voltage})^{3/4}$ dependence. (auth) (UK)

42241 FOCUSED FABRY-PEROT RESONATOR FOR DYNAMIC MEASUREMENTS OF PLASMA DENSITY. Ullschmied, Jiri (Inst. for Plasma Physics, Prague). pp 601-4 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

An open microwave resonator of the Fabry-Perot type was constructed for measuring a time-varying electron density of a plasma created by a pulsed electron beam in a metal vacuum chamber of a magnetic mirror machine. The density was determined from the shift of a resonant frequency of the resonator. The plasma density was directly displayed on an oscilloscope. (M.O.W.)

42242 SPECTROSCOPICAL MEASUREMENTS OF THE ELECTRON AND ATOM TEMPERATURES IN NONEQUILIBRIUM PLASMA. Lego, J.; Ferdinand, J. (Technical Univ., Prague). pp 139-43 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The method for determining ion temperatures, using the ratio of two spectral lines, is generalized for use with nonequilibrium plasmas. The generalization processes is based on particle number balance for a fixed energy level. (M.O.W.)

42243 TEMPERATURE DISTRIBUTION OF THE XENON PULSE-DISCHARGE PLASMA THROUGH THE CROSS SECTION OF A QUARTZ TUBE. Andreev, S. I.; Gavrilov, V. E. Opt. Spectrosc. (USSR) (Engl. Transl.), 26: 66-7(Jan. 1969).

Translated from Opt. Spektrosk., 26: 121-3(Jan. 1969).

An investigation was made of the radial distribution of temperature in pulsed xenon tubes used as radiative sources. The spectral density of the brightness and the absorption of the plasma was measured directly from its transmitted illumination by means of an independent source. (M.O.W.)

42244 COLLECTIVE SCATTERING OF LASER LIGHT FROM LASER-PRODUCED LiH PLASMA. Izawa, Yasukazu; Yokoyama, Masahiro; Yamanaka, Chiyoe (Osaka Univ.). Jap. J. Appl. Phys., 8: 965(July 1969).

The experimental set-up is briefly described. Diagrams of the spectral distribution of the ion peaks after the ruby laser pulse are given. (M.O.W.)

42245 CYLINDRICAL PROBE IN A COLLISIONLESS MAGNETIZED PLASMA. Amemiya, Hiroshi; Dote, Toshihiko (Physical and Chemical Research, Saitama, Japan). Jap. J. Appl. Phys., 8: 818-19(June 1969).

Calculations were made for cylindrical probes with their axis parallel to the magnetic field in a collisionless plasma. (M.O.W.)

42246 DETERMINATION OF ELECTRON CONCENTRATIONS FROM TWO INTENSITY MEASUREMENTS WITHIN THE H LINE. Powell, W. Richard (Johns Hopkins Univ., Silver Spring, Md.). Appl. Opt., 8: 1041-4(May 1969).

A method for calculating the electron concentration in dense plasmas containing hydrogen is suggested which utilizes two intensity measurements at separate points within the profile of the H_β line. The relative intensity observed by two detectors is expressed as a function of the electron concentration, plasma temperature, and instrumental parameters such as resolution and wavelength separation between measurements. Electron concentrations between 10^{15} cm^{-3} and 10^{17} cm^{-3} may be read directly from graphs presented in this article. (auth)

42247 RESONANCE PROBE CHARACTERISTICS IN A NONUNIFORM PLASMA. Aihara, S.; Lampis, G.; Takayama, K. (Nagoya Univ., Japan). Nuovo Cim., Lett., 2: 46-9 (July 11, 1969).

A nonuniform plasma, whose degree of nonuniformity can be artificially controlled, is used for studying the transmission of rf current across it. The radial plasma density distribution, measured by the Langmuir probe method, presents a double exponential decay. (M.O.W.)

42248 A METHOD FOR MEASURING ELECTRON ENERGY DISTRIBUTION IN TIME-VARYING PLASMAS. Milenin, V. M.; Fujiwara, M.; Kawai, Y. (Nagoya Univ., Japan). Jap. J. Appl. Phys., 8: 974-5(July 1969).

A method is described and used to study electron energy distribution in different phases of moving striations. Measurements were made in a hot-cathode discharge in neon under different conditions with the help of a cylindrical probe located in the central part of the discharge tube. (M.O.W.)

42249 PHASE SENSITIVE INTERFEROMETER FOR THE MEASUREMENT OF ELECTRON DENSITY IN TRANSIENT PLASMAS. Dangor, A. E.; Dolby, J. S.; Fielding, S. J. (Imperial Coll. of Science and Tech., London). J. Phys., E (London), 2: 776-8(Sept. 1969).

A birefringent element placed within a Fabry–Perot cavity enables the direction of change of electron density to be unambiguously identified. The only necessary condition is that the birefringent element be oriented so that the plane of polarization of the incident beam is at an angle other than $\pi/4$ to that of the ordinary ray. The operation and design of the interferometer is considered and some electron density measurements in a z-pinch discharge are given. (auth) (UK)

42250 TWO COIL rf DETERMINATION OF PLASMA CONDUCTIVITY. Mikoshiba, S.; Smy, P. R. (Univ. of Alberta, Edmonton). Rev. Sci. Instrum., 40: 1187-91(Sept. 1969).

A new method of measuring the electrical conductivity of a plasma by utilizing the dependence of the mutual inductance of two coils upon the conductivity of the medium lying between them is described. In addition to its simplicity, the method has several advantages over previous single coil measurements; these are (a) high speed response ~0.02 μsec, (b) it gives a measure of the average conductivity in the plasma rather than that very close to the coil, (c) it can be used over a continuous and wide range of frequencies with the result that a very wide range of conductivity can be measured (to 10^6 mhos/m). Electrostatic effects can be eliminated by the use of a third coil which avoids any necessity for electrostatic screening. Measurements have been performed upon electrolytes and plasmas with conductivities from 10 to 10^4 mhos/m at frequencies from 0.1 to 50 MHz, and in every case agreement with theory is excellent. (auth)

42251 INTERACTION OF OPTICAL MASER BEAMS WITH IONIZED GASES. Dougal, Arwin A.; Friedrich, Otto M. Jr. (Univ. of Texas, Austin). Anal. Instrum., 6: 205-13(1969).

From 14th Annual Analysis Instrumentation Symposium, Philadelphia, Pa. See CONF-680550.

Extension of microwave concepts to optical wavelengths, namely, that of plasma filled coupled optical resonators and that of Faraday rotation of the plane of polarization of optical maser beams propagating through magnetoplasmas, have been developed and utilized. Also, optical interferometry and holography are employed to study ionized gases. Optical maser induced electrical breakdown in super-high pressure gases is being investigated experimentally and analytically. Experimental measurements indicate that the breakdown mechanism involves energy gain of free electrons by acceleration in the incident electromagnetic field while undergoing collisions with neutrals, and subsequent electron-impact ionization. This mechanism is described by classical microwave breakdown theory and compares favorably with experimental measurements for helium, argon, hydrogen, and nitrogen over the pressure range 100 to 30,000 psi. Kerr cell, high speed photographs of the focal region provide time resolution of the macroscopic growth of the plasma. Mach–Zehnder optical interferometry is utilized to obtain space and time resolution of the electron density and to study strong blast waves produced by optical maser induced electrical breakdown of gases. (auth)

Kinetics (General)

42252 (AEC-tr-6869/12) UKRAINIAN PHYSICS JOURNAL. Translation of Ukr. Fiz. Zh., 12: 1937-2087(1967). 183p. (TT-67-51421/12; IPST-Cat.-5072). CFSTI.

42253 (NYO-3927-5) [STUDIES IN PLASMA PHYSICS]. Progress Report. Rosenbluth, Marshall N. (Institute for Advanced Study, Princeton, N. J.). May 29, 1969. 9p. Dep. CFSTI.

Brief discussions of research work are given for the following: (1) mirror-confined plasmas, (2) finite amplitude collisional drift waves, (3) effects of finite plasma pressure on microinstabilities, (4) other stability results, and (5) bananas, superbananas, etc. (M.O.W.)

42254 INVESTIGATIONS OF A STREAMING PLASMA IN AN AXIAL MAGNETIC FIELD. Young, Eddie Hung-chung Jr. Austin, Tex., Univ. of Texas, 1968. 131p.

Thesis.

The interaction of the plasma with the magnetic field can be described by the vector magnetic diffusion equation provided that certain conditions are satisfied. The magnetic field equation is reduced to two scalar equations, and their solutions are obtained for two different cases. One is an approximation concerned with semi-infinite plasma; the other is a finite boundary value solution. Computed solutions are compared with experimental curves. The typical conductivity measured is 10^4 mho/m and the electron temperature is then obtained using Spitzer's formula (1.7 eV). In the study of plasma density variations, the analysis is based on the equation of continuity and Fick's Law in which the diffusion coefficients are defined. The calculations of perpendicular and longitudinal diffusion are based on classical methods. Measurements indicate that the plasma density is about $2 \times 10^{21}/m^3$ and the average longitudinal diffusion is about $2600 m^2/sec$. The perpendicular diffusion coefficient measured compares with the maximum estimated value in Taylor's paper. In the course of experimental work, the double-probe current characteristics for a moving plasma are found to be different in nature from those depicted by the Johnson and Malter treatment. A suitable theory has been used to explain the characteristic curves. The experimental data are taken with the use of magnetic probes and electric double probes. Optical techniques such as Kerr cell photography and H_β line-broadening measurements have also been employed. (Disser. Abstr.)

42255 EXPERIMENTAL STUDY OF RESONANCE LOADING IN A DC DISCHARGE. Freeman, Richard Leslie. Austin, Tex., Univ. of Texas, 1968. 110p.

Thesis.

Wave propagation in a bound plasma system was investigated experimentally using a heated cathode dc discharge. Theoretical predictions were based on the solution of Maxwell's equations for a cylindrical plasma bound along the axis by conducting end plates of infinite extent. A magnetic field is applied along the axis, and outside the plasma region is an exciting coil of finite dimensions. The conducting end plates allow a Fourier expansion of the electric fields in terms of the components of the parallel propagation vectors, $k_{||} = n\pi/L$. L is the tube length and n = 1, 3, 5, ... The constants of the electric field expansions are determined from boundary conditions at the plasma–vacuum interface and at the exciting coil. The impedance of the exciting coil is thus determined by evaluating the integral of the divergence of the Poynting vector over a surface surrounding the coil. The impedance of the coil is measured experimentally by using a commercial Q meter. An argon plasma with a charge density of about 10^{11} particles/cm^3 and an electron–neutral collision frequency of several times 10^7 rd/sec was used. The plasma is perturbed by a small-amplitude rf signal in the range from 30 to 60 Mc. Variations of the coil impedance are monitored as the applied axial magnetic field is varied from 0 to 935 gauss. A comparison of theory and experiment is shown for several different operating conditions. The general behavior is described quite well by the theory, but the comparison reveals some deviations from the predicted behavior. The deviations are analyzed on the basis of model deficiencies. Also the relative strength of intrinsic and geometrical resonances are investigated by comparing the experiment to the predictions of a simpler theory which eliminates the cylindrical geometry, and hence, the geometrical resonances. The predictions of the simple theory describe the experiment even better for some operating conditions. (Diss. Abstr.)

42256 FOURTH CZECHOSLOVAK CONFERENCE ON ELECTRONICS AND VACUUM PHYSICS, HELD IN PRAGUE ON OCTOBER 7th-12th, 1968. **Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. 604p. (In several languages). (CONF-681053).**

Separate abstracts were prepared for 40 papers. (M.O.W.)

For abstracts of individual papers see: 42014, 42226, 42241, 42242, 42257, 42268–42276, 42297–42310, 42331, 42340–42343, 42360–42363, 42524, 42812, and 42813.

42257 PLASMA DIFFUSION IN AN INDUCED HIGH-FREQUENCY DISCHARGE. **Waldmann, G. (Kernforschungsanlage, Juelich, Ger.). pp 118-21 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).**

See CONF-681053.

The propagation of a slightly ionized, collision-dominated plasma from a space-limited source region in an initial neutral environment can be explained by a nonstationary ambipolar diffusion current. Comparison of experimental data with calculated rise times from a simplified diffusion model gives satisfactory agreement. Deviations from the theoretical pattern at higher densities must arise from over-simplification by the diffusion model in the application of a site-independent diffusion coefficient. Perturbation effects, which occur probably by local gas heating in the plasma ring, were observed at higher pressures and higher ring field intensities and can have possibly a small effect on the density measurements. (tr-auth)

42258 PRODUCTION AND LOSS OF N_2^+ IONS DURING THE DECAY PERIOD OF PLASMAS PRODUCED IN HELIUM–NITROGEN MIXTURES. DeMonchy, A. R.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Z. Phys., 224: 324–34(1969).

The time dependence of the number density of N_2^+ ions during the decay period of plasmas produced in helium containing 0.05, 0.17 and 0.5 percent nitrogen was studied in the pressure range from about 0.3 to 7 torr by means of mass spectrometer techniques. During the early part of the afterglow period the time dependence of N_2^+ is controlled by ambipolar diffusion loss towards the plasma container walls. The product of the ambipolar diffusion coefficient D_a and the reduced pressure p_0 was $D_a p_0 = 900 \pm 50$ cm^2 torr/sec. The production of N_2^+ by collisions between metastable nitrogen molecules determines the temporal behavior of the N_2^+ density during the late afterglow for extremely pure discharge conditions. From the data it follows that the metastable molecules involved are de-excited by collisions with ground state helium atoms with a rate constant of 3.4×10^{-15} cm^3 sec^{-1}, while the radiative lifetime of these metastable molecules is at least 20 msec. The surface catalytic efficiency for de-excitation upon striking the molybdenum covered plasma container walls was estimated to be smaller than 10^{-3}. Energy and radiative lifetime requirements suggest that N_2^+ is produced during the plasma decay period by the process $N_2(a'^1\Sigma_u^-) + N_2(a'^1\Sigma_u^-) \rightarrow N_2^+(X^2\Sigma_u^+) + N_2(X) + e$. (auth)

Kinetics (Experimental)

42259 (AEC-tr-7052) DETERMINATION OF PLASMA PARAMETERS PRODUCED BY SUPER HIGH-FREQUENCY POWER IN A MAGNETIC FIELD STEADY-STATE CONDITION. Anisimov, A. I.; Vinogradov, N. I.; Golant, V. E.; Nanobashvili, S. I.; Pakhomov, L. P. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of Preprint No. 116. 14p. Dep. CFSTI.

A study was made of plasma produced by the super-high frequency power of a 3-cm wave range under conditions of electron cyclotron resonance. The studies were conducted in hydrogen at pressures of 5×10^{-4} to 10^{-2} mm mercury column and induced by a super-high-frequency power of an order of 200 watts. At the same time, the steady-state concentration of charged particles is found to be within the limits of 10^{11} to 10^{13} cm^{-3} and the temperature of the electrons is found to equal 1.5 to 15 eV. The experimental data are analyzed on the basis of balance equations. (auth)

42260 (IPP-2/76) EFFECTS OF AZIMUTHAL COMPONENTS OF THE ELECTRIC FIELD IN A Q-DEVICE. Guilino, E. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Mar. 1969. 52p. (In German). Dep.

Azimuthal components of the electric field in Q-machine plasmas may occur if the distribution of temperature over the endplate is deviating from rotational symmetry. In this case, $E_\Theta \times B_z$-drifts give rise to plasma loss rates which may be comparable in magnitude to "Bohm Diffusion." This effect is verified experimentally in a double-ended Q-machine (ALMA III). A new heater system for the endplates using rotating cathodes yields temperature distributions which are symmetrical within less than 0.1%. Under these conditions the loss rate is reduced by a factor 10 to 60 as compared to the operation with conventional heater systems. (auth)

42261 DISCHARGE CHARACTERISTICS IN SEEDED FLOWING PLASMA. Biblarz, Oscar. Stanford, Calif., Stanford Univ., 1968. 108p.

Thesis.

An experimental investigation was undertaken to explore the influence of velocity and of temperature on the discharge characteristics of a potassium-seeded argon plasma flow at atmospheric pressure. The conditions were representative of those expected in a noble-gas MHD generator except for the magnetic field which was omitted to permit a more careful observation of the basic discharge phenomena. The apparatus consisted of an argon arcjet heater which discharged into a plenum chamber where 0.1 mass percent potassium vapor (in the form of a sodium–potassium alloy) was injected. A second chamber provided time for thermalization of the plasma and was terminated by a boron nitride nozzle which led to a constant-area test section. The test section was made of quartz and contained two electrodes which were nearly flush with the wall and extended across the channel. For parts of this study, these electrodes were of unequal size in order to fix the electron emission in the flow direction. (Diss. Abstr.) (TSS)

42262 MEASUREMENT OF SPECTRAL LINE PROFILES IN DENSE PLASMAS. James, Harry Gordon. Vancouver, B. C., Univ. of British Columbia, 1968.

Thesis.

The spectra emitted by a pulsed-arc discharge were photographed with a medium-resolution spectrograph to obtain Stark-broadened line images measurable for both width and shift. Plasmas with densities near 10^{17} cm^{-3} and temperatures of about 2.4 eV were produced by subjecting argon–nitrogen mixtures to a square current pulse. Light from the discharge was shuttered by a rotating-mirror system so that the plasma was photographed in an interval during the current pulse when the plasma had optimal conditions for measurement. A technique in which the spectral lines from a standard source are photographed on the same plates as the plasma lines was devised for calibrating the measurement routine and for facilitating shift measurements. Stark parameters were obtained by scanning the plates on a precision comparator. Nineteen Ar II lines and six N II lines were studied. For argon, the agreement with other experimental results is satisfactory but the theory is inadequate. Similarly, the N II theory does not predict the values measured here. On the other hand, some of the qualitative predictions by the impact theory about the line shape and about the common widths and shifts of lines in the same multiplet were confirmed. The experiment on the N II lines also reveals advantages of the present technique over other methods for obtaining Stark parameters. (Diss. Abstr.)

42263 EXPERIMENTAL MEASUREMENT OF THE REFRACTIVE INDEX OF AN ARGON PLASMA AT LIGHT WAVELENGTHS OF 6328 A AND 1.15 μ. Hug, William Frank. Evanston, Ill., Northwestern Univ., 1968. 126p.

Thesis.

A Mach–Zehnder interferometer was used to measure the volumetric distribution of refractive index in an argon plasma at wavelengths of 6328Å and 1.15μ. These measurements were correlated with temperature, measured spectroscopically, from 11,000 to 23,000°K at 1.10 atmospheres pressure. The argon plasma was generated using a free-burning dc electric arc. The volumetric electron density distribution was inferred from the interferometric data, assuming dispersion by free electrons only. Comparison of this data with the spectroscopically inferred electron density distribution is not favorable above 16,000°K. The absolute index of refraction was compared with existing theory and found to be in disagreement above about 15,000°K. The effective ionization limit inferred by a comparison of theory with experiment is in good agreement with some ionization limit theory. (Diss. Abstr.)

42264 PLASMA TRANSPORT IN A MAGNETOPLASMADYNAMIC ARC. Kribel, Robert Edward. San Diego, Calif., Univ. of California, 1968. 151p.

Thesis.

A modified magnetoplasmadynamic (MPD) arc was operated in a pulsed mode to permit internal probing of the arc region. The arc attains steady state operation which strongly resembles the behavior of the more conventional continuous MPD arcs. Spatial surveys with magnetic probes and small Rogowski coil probes show the current distribution to have the form of a well defined radial spoke which rotates azimuthally. The rotation frequency is typically about 40 kc with argon propellant. Observations with double-plane Langmuir probes indicate that the rotating current spoke corresponds to an actual plasma rotation. The plasma density within the spoke is at least an order of magnitude higher than it is at other azimuthal positions. The spoke exhibits an internal structure. The plasma in the leading edge is streaming radially outward, while that in the trailing edge is counterstreaming inward towards the cathode. Most of the arc current flows in the trailing section, and the ions there seem to carry about 30% of the total arc current. Floating double probes have been used to measure the electric field components. The plasma electron temperature was determined from the relative intensities of sixteen argon II lines. The electron temperature is 1.1 ± 0.3 eV everywhere in the spoke. The actual plasma resistivity is obtained from the generalized Ohm's law using measured values of $\vec{E}$, $\vec{v}$, $\vec{B}$ and $\vec{J}$. The observed resistivity is greater than the value calculated from Spitzer's formula by a factor of 4.0 ± 1.5. (Diss. Abstr.)

42265 CERTAIN CHARACTERISTICS OF DISCHARGE IN INHOMOGENEOUS ELECTRIC AND TRANSVERSE MAGNETIC FIELDS. Martynyuk, S. P.; Tkachenko, V. M. (Kharkov State Univ.). Ukr. Fiz. Zh., 14: 693-6(Apr. 1969). (In Russian).

Gas discharge in crossed electric and magnetic fields was studied in relation to concepts of confinement of high-temperature plasma, generation of electromagnetic oscillations, and commutation of high-energy currents. Electrodes in coaxial cylinders, with a fixed axial discharge symmetry during superposition of the magnetic field, were used. Results showed that the ignition voltage and the magnitude of the discharge current can be changed by means of magnetic fields. (R.V.J.)

42266 AN EXPERIMENTAL STUDY OF RADIO-FREQUENCY PLASMAS NEAR THE LOWER HYBRID RESONANCE. Hasti, David Edward. Austin, Tex., Univ. of Texas, 1968. 106p. Thesis.

The resistive loading of a steady-state rf oscillator, operating at power levels of 3 to 4.5 kW in the vicinity of 25 MHz, by inductively coupled argon and hydrogen plasmas is determined experimentally as a function of magnetic field strength. The experimental conditions are designed to match as closely as possible the theory developed by Skipping for a finite-length, cylindrical plasma in a homogeneous magnetic field coupled to a wave generator through a single-turn coil. The experiments covered pressure ranges of 0.050 to 0.260 torr in argon and 0.025 to 0.150 torr in hydrogen. The experimental results are compared with numerical calculations of loading resistance from Skipping's theory and from the loading resistance obtained from the assumption of an infinite length plasma with no propagation along the magnetic field. Generally better agreement is obtained between experimental results and the finite length theory, but the improved agreement is especially noticeable in the case of geometrical coupling resonances associated with radial eigenmodes of the plasma column observed in the argon experiments. The strong resonant behavior near the geometric mean of the ion and electron cyclotron frequencies in hydrogen is described qualitatively by either theory, but the finite length theory gives slightly better quantitative agreement with experimental results. A strong resonance in the vicinity of the geometric mean of the cyclotron frequencies was not observed in argon in agreement with theoretical predictions. (Diss. Abstr.)

42267 ELECTRON GAS BEHAVIOR IN THE BASE AND MIXING REGIONS OF A WEAKLY IONIZED PLASMA FLOW AT AN ABRUPT INCREASE IN CROSS SECTION. Greene, Charles William. Gainesville, Fla., Univ. of Florida, 1968. 111p. Thesis.

Electron behavior in a weakly ionized argon plasma jet (with an initial boundary layer) exhausting into a quiescent medium was investigated. The low-pressure (1 to 20 mm Hg) subsonic jet, studied under conditions which are steady but not necessarily field free, is found amenable to both theoretical and experimental analyses. The flow field of the plasma jet is artificially broken down into three separate regions: the potential core region, the jet mixing region, and the developed flow region. Results obtained in the core and developed flow regions are in agreement with those obtained by other investigators. Particular attention is given to the electron gas behavior in the base and jet mixing regions due to both normal and superimposed potentials in the base region. A mathematical model, based on a known initial electron density profile, is developed for predicting electron number densities within the jet flow. Detailed velocity, electron temperature, and electron number density profiles, obtained using conventional gas dynamic probing techniques, including the Langmuir probe, are presented. (Diss. Abstr.)

42268 HIGH-FREQUENCY BREAKDOWN IN BEAM–PLASMA SYSTEM. Jancarik, J.; Piffl, V.; Seidl, M. (Inst. of Plasma Physics, Prague). pp 46-51 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The effect of high-frequency instabilities in a beam–plasma system on plasma heating and production is experimentally investigated. Time-dependent density measurements are discussed. (M.O.W.)

42269 VELOCITY OF PLASMA IN RAIL ACCELERATORS. Sobra, K.; Sestak, B. (Elektrotechnische Hochschule, Prague). pp 115-17 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).

See CONF-681053.

In a rail accelerator with a transverse magnetic auxiliary field formed externally by a coil fed by condenser batteries, the auxiliary field has no effect on the plasma velocity. Discharge velocities of 10^6 to 10^7 cm/sec could be obtained by alteration of the direction and magnitude of the discharge motion. The auxiliary field did affect the plasma formed by a discharge at initial pressures of 10^{-5} torr, and acceleration of 10^8 cm/sec was obtained. (J.S.R.)

42270 VALIDITY RANGE OF THE NOVAK RELATION. Pfau, S.; Rutscher, A. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). pp 217-21 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).

See CONF-681053.

It was established that the Novak relation is satisfactorily valid for the quasi-neutral low-current, low-pressure discharge. It can be used in this area for the characterization of individual stratified types. Deviations from this relation occur in the transition to medium-pressure discharge or to high-current discharge. (tr-auth)

42271 STUDY OF IONIZATION WAVES AND DETERMINATION OF SEVERAL TRANSPORT PARAMETERS IN ACTIVE PLASMAS. II. EXPERIMENTAL TECHNIQUES AND RESULTS. Sicha, M.; Drouet, M. G.; Cloutier, G. G. (Univ. of Montreal). pp 212-16 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Experimental measurements on the variations of electron temperature, electron density, light intensity, and electric field in slow and fast ionization waves of small amplitude in neon are presented. (M.O.W.)

42272 APPEARANCE OF VARIOUS ION WAVE TYPES IN NOBLE GAS DISCHARGE AT LOW PRESSURE. Hinzpeter, G. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). pp 232-7 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).

See CONF-681053.

The appearance of various ion wave types was investigated in neon in the pressure range from $10^{-3} < p < 1$ torr at currents up to 200 mA. With decreasing pressure down to 10^{-2} torr, self-excited rapidly moving layers were observed, whose phase velocity was strongly increased when frequency and wavelength increase simultaneously. Below this pressure another wave type occurs, whose propagation direction is opposite to that of the moving layer. In the transition range another wave type is observed at low pressures. This wave type has a remarkably low velocity and appears simultaneously with the moving layer. (J.S.R.)

42273 IONIZATION WAVES IN HYDROGEN. Stirand, O.; Laska, L. (Inst. of Physics, Prague). pp 229-31 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

A study of hydrogen in positive column glow discharges has shown that both forward and backward ionization waves appear and that they depend on pressure and current. Diagrams showing different types of ionization waves are given. (M.O.W.)

42274 EFFECT OF IMPURITIES ON THE AFTERGLOW STUDIES IN ARGON AND NEON. Lukac, P. (Comenius Univ., Bratislava). pp 172-7 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Electron density variations were measured as a function of conditions of gas purification. The effect of impurities on mobility coefficients is described. (M.O.W.)

42275 ELECTRON-KINETIC PHENOMENA IN REFLEX DISCHARGES. Kutcherenko, E. T.; Saenko, V. A. (Kiev State Univ.). pp 19-25 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–

12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.
See CONF-681053.

Reflex cell characteristics (Penning cell) were studied under the conditions where the volume charge effects and other minor phenomena in a cell volume are negligible. The necessary and sufficient conditions for electron kinetic phenomena are discussed. (M.O.W.)

42276 ION BALANCE OF THE POSITIVE COLUMN OF A HYDROGEN GLOW DISCHARGE. Schmidt, Martin (Institut fuer Gasentladungsphysik, Greifswald, Ger.). pp 167-71 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).
See CONF-681053.

On the basis of mass spectrometric measurements on the column plasma of the H_2 low-pressure glow discharge, a study was made to determine which elementary processes lead to the appearance of the observed ion composition. The Pahl method of ambipolar effusion of the charge carrier was used, as it permits a comparison of the theoretical and experimentally determined values of the wall loss. Results show that the carrier production results from the direct ionization of the hydrogen molecule and the H_2^+ ions are converted almost completely into H_3^+ ions. The observed H^+ fraction comes almost completely from ionization of H atoms. (J.S.R.)

42277 POSITIVE COLUMN IN A LONGITUDINAL MAGNETIC FIELD. Toader, Emil I. (Univ. of Bucharest). Rev. Roum. Phys., 14: 37-44(1969).

The behavior of the positive column in the presence of a longitudinal magnetic field with a maximum intensity of 3600 gauss was studied in helium and neon at pressures comprised within the range 0.5- to 4-mm Hg. For the experimental conditions, a good agreement is obtained between the collision diffusion theory and the experiment, up to a certain critical magnetic field B_c. For stronger fields, the longitudinal electric fields indicate a much higher diffusion rate across the magnetic field than that expected from the binary collision theory. The dependence of the critical magnetic field on the kind of gas, pressure and the tube radius are in good agreement with the predictions made by the perturbation theory of Kadomtsev–Nedospasov and Hoh's theory for a pressure range of 0.5- to 1.5-mm Hg. For pressures over 1.5-mm Hg, Hoh's theory becomes unacceptable, while the agreement of the K–N theory with experiment, deteriorates. (auth)

42278 DOPPLER-BROADENED SPECTRAL EMISSION FROM THE TURBULENTLY HEATED PLASMA OF BURNOUT V. Alexeff, I.; Guest, G. E.; McNally, J. R. Jr., Neidigh, R. V.; Scott, F. R. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 23: 281-3(Aug. 11, 1969).

In an efficient ion heating mode recently discovered in the Burnout-V turbulent-heating experiment, the line profiles of emission spectra exhibit three noteworthy features: (1) a marked Doppler broadening (full width at half-maximum ≈10 Å) of the Balmer lines, (2) a "red"/"blue" asymmetry dependent on the geometry of the plasma container, and (3) non-Gaussian line shapes near the central wavelengths. (auth)

42279 PLASMA TRANSFER BETWEEN LINEAR OCTOPOLE AND LINEAR QUADRUPOLE GUIDE FIELDS. Kribel, R. E.; Angel, T. (Gulf General Atomic Inc., San Diego, Calif.). Kakuyugo Kenkyu, 23: No. 2, 87-106(June 1969). (In Japanese).

A coaxial plasma gun was used to inject a hydrogen plasma axially into a composite linear multipole guide field. The guide field consists of an octopole section 1.2-m long followed by a quadrupole section of the same length. Plasma is transferred from the octopole section to the quadrupole section with an efficiency of at least 50%. Circulating plasma currents having the general shape of a convection cell have been detected in the octopole. Observations have been made using directional Langmuir probes, magnetic probes, calorimeters, and spectroscopy. (NSA of Japan)

42280 MEASUREMENT OF THOMSON AND RAYLEIGH SCATTERING IN A PREIONIZATION Z PINCH. Roehr, H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 225: 494-502(1969).

A 90° scattering experiment with a preionization z-pinch is described. The first part describes conventional measurements of the electron temperature and density (Thomson scattering). In the second part of the experiment Rayleigh scattering from excited hydrogen atoms was observed during very early phases of the discharge. This observation is possible because the Rayleigh scattering cross section of hydrogen atoms in the second and third quantum states is very large because of the small differences in the energy of the photons of H_α(6563 Å) and the light of a ruby laser (6943 Å). Spectral resolution of this part of the scattered light yields a minimum value for the ion temperature. (auth)

42281 PRODUCTION OF He^+ IONS BY MUTUAL COLLISIONS BETWEEN METASTABLE HELIUM ATOMS. Veatch, G. E.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Phys. Rev., 184: 202-8(Aug. 5, 1969).

The time dependence of the He^+ ion density has been studied during the decay period of plasmas produced in helium and helium containing $5 \times 10^{-3}\%$ neon. The results show that during the early afterglow period the time dependence of the He^+ density is determined by the He^+ loss processes, while during the late afterglow period this time dependence may be governed by He^+ production due to mutual collisions between triplet metastable helium atoms. The experimental conditions for observing the influence of the He^+ production process on its decay rate are discussed. (auth)

42282 STUDY OF THE MECHANISM OF SPECTRUM EXCITATION IN A HELIUM ARC PLASMA. Aleksandrov, V. Ya.; Gurevich, D. B.; Podmoshenskii, I. V. Opt. Spectrosc. (USSR) (Engl. Transl.), 26: 18-20(Jan. 1969).
Translated from Opt. Spektrosk., 26: 36-41(Jan. 1969).

The diagnostics of the plasma of a helium arc indicates large deviations from thermodynamic equilibrium. This is caused by the violation of detailed equilibrium conditions for the ionization and recombination processes in the discharge region. The plasma parameters at a current of I = 5A and the atmospheric pressure are: $n_e = 3 \times 10^{14}$ cm^{-3}, $n_a = 2 \times 10^{18}$ cm^{-3}, $T_e = 18{,}000°$ and $T_r = 4500°$. The investigations showed that for $n > 3$, the relative distribution of atoms among the excited states is determined by collisions with atoms. An estimation of the efficiency of this process was made. The continuous spectrum in the visible and near-ultraviolet regions is determined mainly by the deceleration of electrons in the atomic field. (auth)

42283 NONLINEAR BEHAVIOR OF TONKS–DATTNER RESONANCES DUE TO RF GENERATION. McIntosh, R. E.; DeMambro, J. A. (Univ. of Massachusetts, Amherst). J. Appl. Phys., 40: 3062-3(June 1969).

Evidence is presented that suggests that the ionization mechanism may be responsible for the resonance behavior observed by Hsuan et al. This mechanism was studied experimentally by interacting a microwave signal at 2.7 GHz with the positive column of various gas discharges. The variations in the Tonks–Dattner resonances of the column were observed to be dependent on the input power, the neutral background pressure, and the ionization potential of the gas. (M.O.W.)

42284 OBSERVATION OF DYNAMIC SPECTRUM OF RADIATION FROM A HIGHLY IONIZED DENSE PLASMA. Gudzenko, L. I.; Kaitmazov, S. D.; Medvedev, A. A.; Shklovskii, E. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 9: 341-3(May 20, 1969).
Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 561-4(May 20, 1969).

The dynamic spectrum of the radiation from a plasma produced by a laser pulse in sodium vapor was studied. The sodium emission spectra were recorded with a high-speed moving-image camera with an electron-optical converter. (M.O.W.)

Kinetics (Theoretical)

42285 (AEC-tr-7051) INDUCED COMPTON EFFECT IN PLASMA AND ELECTROMAGNETIC WAVES UNDER ASTROPHYSICAL CONDITIONS. Tsytovich, V. N.; Chikhachev, A. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17750. 25p. Dep. CFSTI.

An abstract for the original paper appeared previously in NSA 23: 12470. (M.O.W.)

42286 (AEC-tr-7058) INFLUENCE OF ELECTRIC FIELD ON THE MOTION OF PARTICLES IN HELICAL FIELDS. Popryadukhin, A. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of a Russian Preprint No. 99. 25p. Dep. CFSTI.

The influence of deviation of equipotentials from the magnetic surfaces on the motion of individual particles is investigated. It is shown that, besides the regrouping of particles in the velocity space, the electric field of "flat" harmonics may result in trajectory mixing, exceeding considerably the Larmor radius. (auth)

42287 (AWRE-O-20/69) THE THERMODYNAMIC PROPERTIES OF ARGON PLASMA IN LOCAL THERMODYNAMIC EQUILIBRIUM, OVER THE RANGE 1 TO 30 ATMOSPHERES

PRESSURE AND 5000 TO 60,000°K TEMPERATURE. Turner, R. G.; Worsfold, Winifred E. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1969. 235p. Dep. CFSTI (U. S. Sales Only). UK 30s. 0d.

The results of some computer calculations of equilibrium chemical composition and thermodynamic properties of ionized argon in local thermodynamic equilibrium (LTE) over the range of temperatures 5,000 to 60,000°K at 100°K intervals and 1 to 30 atmospheres pressure are given. Basically, this represents extension to higher temperatures and pressures of work done by K. S. Drellishak et al. (Phys. Fluids 6: 1280 (1963)). (auth) (UK)

42288 (N-69-25394) ANALYSIS OF ELECTRON ANALOG SIMULATION OF ION CONTAINMENT IN MAGNETIC FIELDS. Milder, Nelson L.; Kaufman, Harold R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1969. 33p. (NASA-TN-D-5217). CFSTI.

The π-theorem of dimensional analysis has been used to obtain similarity parameters characterizing the interaction of a charged-particle gas with a magnetic field. These parameters are used to derive scaling relations for simulating ion-containment systems with electron-containment systems (electron analogs). The scaling conditions are used to correlate the results of an electron-containment experiment to a similar ion-containment experiment, both reported in the literature. The analysis is extended to include a discussion of the possibility of collisionless plasma simulation. Plasma-containment simulation is considered from the viewpoint of the stability of static systems. The theoretical possibility of flute instability simulation is discussed. (auth)(STAR)

42289 (NYO-3782-3) PROPERTIES OF THE HIGH BETA PLASMA STATE. Progress Report, September 15, 1968–July 31, 1969. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). Contract AT(30-1)-3782. 100p. Dep. CFSTI.

Stability calculations are presented for shock-like disturbances propagating across collisionless high-β plasmas. Turbulent plasma studies are described for the following areas: (1) turbulent heating processes, (2) nonlinear stabilization of hf instabilities in magnetic fields, (3) transport processes, (4) nonlinear beam–plasma interactions, and (5) nonlinear theory of ion–acoustic waves. A theoretical analysis of cyclotron resonance heating in magnetic traps is presented. In addition, the following three papers are included as appendices: (1) Finite Larmor Radius Effects in Plasmadynamics–Magnetosonic Disturbance, (2) Finite Larmor Radius Effects in the Magnetosonic Pulse, and (3) Solitary Waves in a Magnetoplasma. (M.O.W.)

42290 (SU-IPR-294) COMPACT NON-ITERATIVE POISSON SOLVER. Buneman, O. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 11p. Dep. CFSTI.

Subroutine "XYPOIS" converts a two-dimensional array of M by N charges Q into the corresponding array of potentials. It solves Poisson's equation in the finite-difference form: $2\Phi - \Phi_{\text{above}} - \Phi_{\text{below}} /S + 2\Phi - \Phi_{\text{left}} - \Phi_{\text{right}} = 2Q$ where S is the square of the cell ratio, $S = (\Delta Y/\Delta X)^2$. The same array is used for the final potentials as for the initial charges. (auth)

42291 QUANTUM THEORY OF THE PLASMA–RADIATION INTERACTION. II. Peyraud, J. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 30: 461-76(May–June 1969). (In French).

The results and methods described previously (J. Phys. (Paris), 30: 307(1969)) are applied for determination of the emission–absorption processes in a plasma, both for incoherent and coherent radiation. (auth)

42292 EFFECTS OF NONELASTIC COLLISIONS IN PARTIALLY IONIZED GASES. Shaw, James Franklin. Stanford, Calif., Stanford Univ., 1968. 148p.
Thesis.

A self-consistent solution of the coupled free-electron Boltzmann equation and the rate equations for the population of the excited levels of a monatomic gas is presented, taking into account both nonelastic collisions and radiation losses. Appropriate forms of these equations for a monatomic, partially ionized gas are obtained. Next, an approximate set of rate equations is solved for several different cases and an easily evaluated criterion for the validity of the Saha equation is derived from these equations. Approximate forms of the Boltzmann equation, including the effects of nonelastic collisions, are solved analytically to obtain the distribution function. These solutions coupled with an approximate rate equation yield algebraic formulas for the first excited level population. The coupled Boltzmann equation and the rate equations for a model atom provide a qualitative model for predicting the first-excited-level population, the distribution function, and either the steady-state electron number density, or the net ionization rate. Results based on this model are presented, and include a discussion of the conditions necessary for the validity of the Saha equation at the electron temperature. Next, a numerical solution method for the solution of the coupled equations is presented. An iterative numerical scheme is used to obtain self-consistent electron distribution functions, excited atom level populations, and ionization rates in a monatomic partially ionized gas. A special numerical filtering technique is used to obtain the distribution function. Results for hydrogen plasmas and for cesium–argon plasmas are presented and discussed. It is shown that photon escape and nonelastic collision caused a depression in the distribution function tail in the steady-state electron number density, and in the collisional–radiative ionization rate. Large radiation escape factors and low electron number densities lead to large depressions relative to equilibrium values. Results based on the previously presented analytical solutions of Part I are compared with the numerical results and found to be in good agreement. (Diss. Abstr.)

42293 SELF-FOCUSING OF LASER BEAMS IN A PLASMA BY PONDEROMOTIVE FORCES. Hora, Heinrich (Institut fuer Plasmaphysik, Garching, Ger.). Rensselaer Polytechnic Inst., Hartford, Conn.). Z. Phys., 226: 156-9(1969).

Self-focusing of a laser beam in a plasma is treated in terms of the ponderomotive acceleration due to the gradient of the light intensity. The focusing of radiation within the first minima of diffraction sets a lower limit to the laser power which is of the order of 1 MW for the usual lasers if cutoff density and a plasma temperature of about 10 eV are assumed. (auth)

42294 SYNCHROTRON RADIATION IN A BOUNDED COLD MAGNETOPLASMA. Motz, H. (Oxford Univ.). Acta Phys. Austr., 28: 139-48(1968).

The radiation emitted by an electron in helical motion along the direction of a uniform constant magnetic field in a wave guide uniformly filled with cold plasma was studied. Physically, such a uniform distribution may be realized by making the walls of the wave guide out of a fine meshed metal gauze with openings that allow the plasma to pass through. For radiation with wavelength large compared to the mesh size, the mesh will behave like a continuous conducting surface. No sheath problems are considered, and the conductivity of the wall was assumed to be infinite. (M.O.W.)

42295 A KINETIC-THEORY BOUNDARY-VALUE PROBLEM IN A FLOWING PLASMA: THE IMPEDANCE OF A GRID PAIR. Mioduszewski, Daniel Paul. University Park, Pa., Pennsylvania State Univ., 1968. 105p.
Thesis.

A technique was developed for handling a class of plasma kinetic theory boundary-value problems where plasma flows are taken into account; then it was applied to the problem of calculating the impedance of a grid pair through which a plasma is flowing perpendicularly to the grids. The Fourier–Laplace transforms are used to solve the problem after the inclusion of the boundary values into the differential equations. Graphs of the impedance are obtained for various parameters. It is shown that the negative resistance, which Rydbeck showed could exist using the cold-electron fluid theory, is a drift phenomenon and does not exist for a stationary plasma. In addition, it is also shown that Debye shielding disappears when the drift velocity becomes much greater than the thermal velocity of the plasma and that Debye shielding is directly related to the fast wave of the cold electron fluid theory. (Diss. Abstr.)

42296 NOISE SPECTRUM RECEIVED BY AN ANTENNA IN A PLASMA. Fejer, J. A.; Kan, J. R. (Univ. of California, San Diego, La Jolla). Radio Sci., 4: 721-8(Aug. 1969).

A general expression for the noise spectrum received by an antenna in an isotropic plasma is derived by using a combination of plasma fluctuation theory and the reciprocity theorem. The special case of Maxwellian velocity distributions of the constituents is then considered. In the still more special case of thermal equilibrium, Nyquist's theorem is shown to be satisfied. It is shown that a "Maxwellian" energetic electron constituent carrying only a small fraction of the total thermal energy can enhance the spectral power density of antenna noise just above the plasma frequency. The maximum enhancement factor is equal to the square of the ratio of the "thermal" velocities of the high- and low-energy electrons. There is no such enhancement in the resistance of the antenna. (auth)

42297 SOME NEW RESULTS CONCERNING THE RADIATION PRESSURE ON THE PLASMA–VACUUM BOUNDARY. Klima, R.; Petrzilka, V. A. (Inst. of Plasma Physics, Prague). pp 57-61 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The radiation pressure on a plasma when the wave falls on the plasma from the vacuum side was theoretically investigated, using several models. (M.O.W.)

42298 A NOTE ON THE FORM OF THE RESONANT TERMS IN THE MODEL OF A PERIODIC SLAB INCLUDING THE PARTICLE MIRRORING IN THE FIELD. Rohlena, K. (Inst. of Physics, Prague). pp 52-5 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Recently, the problem of low-frequency electrostatic waves in complex magnetic fields such as multipole confinement has been receiving increased attention. A certain obvious simplification of the complex geometry treatment is the periodic slab model simulation, e.g., the multipole situation either by a weak periodic modulation of the straight field in the usual infinite slab model or by imposing a small periodic gravity to simulate the field curvature. Both models give essentially the same results. However, these simplified models do not account for a particle trapping. The periodic slab model was extended to the case of the varying particle velocity along the field lines. Treatment of the imaginary part of the linearized electron density perturbation, which finally would drive a universal instability is outlined. (auth)

42299 ELECTRON CYCLOTRON RESONANCE LINE FORMATION BY NEGATIVE ABSORPTION IN GASES. Durcek, J. pp 86-92 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).

See CONF-681053.

For monoenergetic electrons in electron cyclotron resonance, the line form is the Lorentz axis in negative as well as in positive absorption. For Maxwell-Boltzmann velocity distribution, the negative absorption can occur only outside resonance and is much weaker than the positive absorption in resonance. The line form deviates sharply from the Lorentz axis. (tr-auth)

42300 STATIONARY SOLUTIONS OF THE VLASOV EQUATION WITH EXTERNAL ELECTRICAL FIELDS AND BGK COLLISION TERMS. Christoph, Gernot (Arbeitsstelle fuer Statistische Physik, Leipzig). pp 80-5 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

A neutral two-component plasma was assumed to be infinite in extent. The stationary electron distribution function was found from the one-dimensional Vlasov equation including an external periodically space- and time-dependent electric field and a BGK collision term. (M.O.W.)

42301 CALCULATIONS OF PLASMA PARAMETERS BEHIND THE SHOCK FRONT IN HELIUM. Labat, J.; Cadez, V. (Inst. of Physics, Belgrade). pp 111-14 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Parameters of a plasma behind the shock front were calculated from the set of Rankine-Hugoniot equations for the mass, momentum and energy conservation. Ionization graphs are given. (M.O.W.)

42302 THE SAHA EQUATION AND LOWERING OF THE IONIZATION ENERGY FOR A TWO-TEMPERATURE PLASMA. Veis, S. (Comenius Univ., Bratislava). pp 105-10 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The Saha equation is derived for a two-temperature plasma, considering at the same time the Coulomb interaction of charged particles, and also with determination of lowering of the ionization energy. (M.O.W.)

42303 KINETIC ENERGY DISTRIBUTION FOR IONS REACHING THE WALL OF THE DISCHARGE TUBE AT THE LOW-PRESSURE REGIME. Martisovits, V. (Comenius Univ., Bratislava). pp 161-6 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The radial potential distribution in the positive column has an influence upon the energy distribution function of ions reaching the tube wall. The ions formed at the wall are accelerated by the smaller potential drop than ions formed near the axis. In the positive column at low pressures the loss of ion energy caused by collisions with neutral particles can be neglected and therefore the distribution function of ion energy can be calculated directly from the radial course of the potential and ion energy. (M.O.W.)

42304 TRANSPORT COEFFICIENTS IN HELIUM. Ruzicka, Tomas (Inst. of Physics, Prague). pp 155-60 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The Boltzmann equation was solved for the transport coefficients of helium. Diagrams showing the results are discussed. (M.O.W.)

42305 DISTRIBUTION FUNCTION FOR HELIUM DISCHARGE AT LOW CURRENT DENSITIES. Ruzicka, Tomas (Inst. of Physics, Prague). pp 149-54 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

A special form of the Boltzmann equation was solved for helium by means of a digital computer. The restrictions of applicability of the equation are: (1) low electron densities; (2) a moderate value of E/p_0 ($\sim E/N$); (3) there are no variations in configuration space (a space-homogeneous case). (M.O.W.)

42306 THE ELECTRON ENERGY DISTRIBUTION IN AN ELECTRIC DOUBLE LAYER. Hoelscher, J. G. A. (Technische Hogeschool, Eindhoven, Netherlands). pp 144-8 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The electron energy distribution in moving striations in positive column discharges is studied theoretically. It is assumed that the layers observed in the striations can be described as electric double layers in which the field is homogeneous. (M.O.W.)

42307 EFFECT OF THE DISTRIBUTION FUNCTION ON THE NOISE TEMPERATURE OF PLASMA. Heymann, P. (Physikalisch-Technisches Institut, Berlin). pp 134-8 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).

See CONF-681053.

The applicability of standard types of distribution functions to the description of the behavior of the high-frequency parameters of a plasma was investigated. The equation for the radiation temperature of a weakly ionized plasma was evaluated for various values of the parameter n. Results show a dependence of the radiation temperature on the measurement frequency and the neutral gas pressure with increasing value of the exponent. It was concluded that for the diffuse-medium pressure column, the standard distribution represents a usable, but not ideal, approximation. (J.S.R.)

42308 STUDY OF IONIZATION WAVES AND DETERMINATION OF SEVERAL TRANSPORT PARAMETERS IN ACTIVE PLASMAS. I. THEORY. Drouet, M. G.; Sicha, M.; Cloutier, G. G. (Univ. of Montreal). pp 206-11 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

It is shown that by using the equations of conservation of particles and electron energy in their general form it is possible to develop some expressions for such transport parameters as the electron thermal relaxation length, the ratio D_e/μ_e, and α_i, the derivative of the ionization frequency with respect to the electron mean energy. (M.O.W.)

42309 STUDY OF THE DERIVATIVE OF RELAXATION LENGTH OF ELECTRON TEMPERATURE. Prostejowsky, Jiri (Charles Univ., Prague). pp 201-5 of Fourth Czechoslovak

Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).
See CONF-681053.

A method is described for the derivation of the differential equation for the electron temperature and field intensity in the positive column of the low-pressure discharge. The equation gives special expressions for a_1 (reciprocal value of the relaxation length of the electron temperature) and b_1 (a constant). (tr-auth)

42310 UPPER EXISTENCE LIMIT OF STRATIFIED HIGH-FREQUENCY DISCHARGE. Wojaczek, K. (Physikalisch-Technische Institut, Berlin). pp 197-200 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968. (In German).
See CONF-681053.

Equations are derived that describe the stratification mechanism in the general case where an external electrical field is operating in addition to the hf field. These equations were tested with measurements made on hf discharge in Ar. The measurements showed that the equations qualitatively describe the stratified hf column. (J.S.R.)

42311 PERIODIC BEHAVIOR OF NEUTRAL GAS PRESSURE IN NONSTATIONARY GAS DISCHARGES. Eidmann, Klaus (Univ., Marburg, Ger.). Beitr. Plasmaphys., 9: 157-63(1969). (In German).

The periodic and spatial behavior of a neutral gas in the residual period of a gas discharge burning in a closed vessel was calculated from a linearized motion equation for a compressible medium. For comparison of the small free wavelengths of neutral particles from the vessel expansion, approximation expressions are given for the pressure, temperature, and current flow. (tr-auth)

42312 INVESTIGATIONS ON THE DYNAMIC BEHAVIOR OF POSITIVE COLUMNS OF LOW-CURRENT DISCHARGES AT AVERAGE PRESSURES. Deutsch, H.; Pfau, S. (Ernst-Moritz-Arndt Univ., Greifswald, Ger.). Beitr. Plasmaphys., 9: 129-40 (1969). (In German).

Beginning with the equilibrium equation of the positive column, assuming a quasi-stationary approximation of the energy distribution of electrons, the dynamic behavior of the column for small disturbances was calculated and compared with experimentally obtained values. Measurements of column impedance were carried out, along with measurements of oscillation magnitudes of excited atoms in relation to the frequency of the superposed disturbance, to confirm theoretical results. Characteristic of the dynamic behavior of the column at average pressure is the appearance of a strongly impressed resonance effect. (tr-auth)

42313 INFLUENCE OF CATHODE CHARACTERISTICS ON PLASMA IN A POSITIVE COLUMN. Bito, J. F. (Forschungsinstitut fuer Elektronik, Budapest). Beitr. Plasmaphys., 9: 117-27(1969). (In German).

Cathode characteristics and their relation to low-pressure discharges with oxide cathodes are considered. Mechanisms and models are given. The influence of emission characteristics on the cathode event, the length of the cathode space, and the introduction at the cathode of the plasma of a positive column are described. Axial distribution investigations are reported. (tr-auth)

42314 TIME-DEPENDENT PHENOMENA FOR A WEAKLY IONIZED PLASMA IN AN EXTERNAL ELECTRIC FIELD. Stenflo, Lennart (Uppsala Univ.). Ark. Fys., 38: 267-76(1968).

A weakly ionized plasma in an external electric field was studied for velocity-dependent collision frequencies under conditions of runaway as well as pure relaxation. The time-dependent velocity distribution function for the carriers was calculated, and runaway rates were estimated. For the steady-state case, the problem of stability against low-frequency longitudinal oscillations was also examined. Comparisons with previous results are made. (Sweden)

42315 UNIFIED APPROACH TO FIELDS AND PROPAGATION IN COMPRESSIBLE LOSSY MAGNETOPLASMA. Talekar, V. L.; Rawat, S. S. (Malaviya Regional Engineering Coll., Jaipur, India). Int. J. Electron., 26: 29-39(Jan. 1969).

For the study of radiation from sources in homogeneous compressible lossy magnetoplasma a linearized hydrodynamic description of the plasma, with positive ions at rest, is used in conjunction with Maxwell's equations. The governing equations were reformulated in matrix form in which a tensor characteristic of the compressible magnetoplasma was used. From this unified formulation, uncoupled wave equations were deduced for radiation fields of various sources, namely the electric current source, the magnetic current source, the mechanical body force source, and the electron flux source. The uncoupled wave equation of the electric field vector was then solved, by the method of the dyadic Green's function, term by term, to give fields of each of these sources. Also from this formulation, a general dispersion relation for lossy magnetoplasma was deduced. Propagation parallel and perpendicular to the static magnetic field were studied as particular cases. (auth) (UK)

42316 FLOW BEHIND TWO-DIMENSIONAL UNSTEADY SHOCKS IN CONDUCTING GASES. Sachdeva, S. K.; Mishra, R. S. (Univ. of Allahabad, India). Tensor, 18: 1-7(1967).

For unsteady plane flows it is proved that, in addition to generating vorticity, the shock waves in conducting gases generate electric current also. Secondly, it is shown that the expression for vorticity in conducting gases, in contrast to nonconducting gases, depends on the thermodynamic behavior of the fluid. (auth)

42317 NONLINEAR EFFECTS OF LASER PROPAGATION IN DENSE PLASMAS. Kaw, Predhiman (Princeton Univ., N. J.). Appl. Phys. Lett., 15: 16-18(July 1, 1969).

Two nonlinear effects of laser propagation in dense plasmas have been analytically investigated, viz., laser penetration into an overdense plasma and the self-focusing of a laser beam. It is concluded that for laser powers currently being used, both these effects can be quite important. (auth)

42318 TRANSPORT PROPERTIES OF A PLASMA IN A STRONG MAGNETIC FIELD. Gilbert, Barry Jay. Bethlehem, Pa., Lehigh Univ., 1968. 107p.
Thesis.

The kinetic description for a plasma in a strong external magnetic field has recently been developed by Radin, Kritz, and Sandri in a form suitable for transport property calculations. The magnetic field effects are expressed by the presence of a dimensionless parameter ω_c/ω_p where ω_c is the cyclotron frequency, and ω_p is the plasma frequency. A magnetic field is considered strong when it not only affects the trajectories of particles between collisions, but also when the collision process itself is altered by the presence of the field. One here considers in detail a field corresponding to the regime $\omega_c/\omega_p \leq 1$. Longitudinal transport coefficients are calculated by expanding the lowest order one-particle distribution in a perturbation expansion in ω_c/ω_p. The first term in this expansion corresponds to the case where the magnetic field is zero. The first non-vanishing correction to these results is proportional to the square of the magnetic field intensity. The calculation of these transport coefficients is broken up into the specific contributions from electron-electron collisions and electron-ion collisions. It is shown that the electron–ion collisions do not contribute to either the electrical or thermal conductivity correction terms. The electron-electron collision contribution is calculated explicitly. (Diss. Abstr.) (TSS)

42319 QUASILINEAR RELAXATION OF AN ELECTRON BEAM IN AN INHOMOGENEOUS PLASMA. Ryutov, D. D. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 57: 232-46(July 1969). (In Russian).

The one-dimensional problem of quasilinear relaxation of an electron beam in a plasma with small concentration inhomogeneities is investigated. It is shown that if the effect is taken into account the set of quasilinear equations are appreciably modified. In particular in the presence of small concentration inhomogeneities quasilinear relaxation leads to the appearance of electrons with velocities appreciably exceeding the initial beam velocity. The role of regular concentration inhomogeneities in the problem of stationary injection of a beam into plasma semi-space is also elucidated. (auth)

42320 DIFFERENTIAL APPROXIMATION FOR RADIANT ENERGY LOSSES IN NONEQUILIBRIUM PLASMAS. Harstad, K. G. (Jet Propulsion Lab., Pasadena, Calif.). J. Quant. Spectrosc. Radiative Transfer, 9: 1273-83(Sept. 1969).

The radiation source function for a nonequilibrium plasma or gas is expanded in a Taylor series in optical depth. The series is truncated and the resulting simplified form is used to express the local radiant energy loss as a differential expression. An example of an isolated optically thick resonance line having the Lorentz profile for its wings is considered. (auth) (UK)

42321 WEAK ELECTRON BEAMS IN INHOMOGENEOUS PLASMA. Baker, John C. (Manned Spacecraft Center, Houston, Tex.). Phys. Rev., 184: 214-18(Aug. 5, 1969).

The one-dimensional single-particle distribution function is expanded into a double Hermite series and the Vlasov equation is solved for inhomogeneous plasmas containing a weak electron beam. All the nonlinear terms in the Vlasov equation are retained. The resulting oscillating electric field is analyzed and the wave spectrum is found to peak at a phase velocity of twice the beam velocity in some cases, contrary to assumptions made for homogeneous plasmas. Wave–wave coupling is thus found to be an important effect in inhomogeneous beam–plasma systems. (auth)

42322 SELF-SIMILAR SOLUTION OF NAVIER–STOKES EQUATION FOR COMPLETELY IONIZED HYDROGEN PLASMA (PROBLEM FOR A PLANE PISTON). Luk'yanova, R. G.; Fadeev, S. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 34-9(May–June 1969). (In Russian).

The motion of completely ionized hydrogen plasma was studied for problems of the plane plunger and the energy release on a stationary surface. Results were obtained for numerical integration of the corresponding system of ordinary differential equations. The constructed graphs show that the behavior of hydrodynamic magnitudes is typical for motions in the electron-ion media. However, the temperature of ions in the plunger was higher than the temperature of electrons in the region directly behind the shock. Data obtained for the energy release on the stationary wall revealed a reverse ratio of the ion-electron temperatures. The sharp increase of ion temperature diminished with the increase of energy supplied on the plunger to the electron gas. (R.V.J.)

42323 AN EXPONENTIAL FORMULA FOR SOLVING BOLTZMANN'S EQUATION FOR A MAXWELLIAN GAS. McKean, H. P. Jr. (Rockefeller Univ., New York). J. Comb. Theory, 2: 358-82(1967).

A class of nonlinear Boltzmann-like equations is interpreted from a probabilistic point of view. The model leads to an exponential formula for the solution, which, in the special cases considered, can be made explicit by algebraic and combinatorial considerations involving derivations of an associated algebra and exponentials of these and a (commutative but possibly nonassociative) multiplication (convolution) on a dual of this algebra. Kac's idea of "propagation of chaos" plays a central role in all this. (auth)

42324 SOME PECULIARITIES OF TORSION SCATTERING. Faingol'd, M. I. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 50-5(1968). (In Russian).

The changes in energy and angular distribution, generalization of the inverse problem, and the additional contributions of the collision integral which appear during torsion or spiral scattering are discussed. The formulas developed for the above effects can be used for plasma in cases where the law of plasma particle interactions is known. (R.V.J.)

42325 EXACT EXPRESSION FOR THE THERMAL CONDUCTIVITY OF A LORENTZ GAS IN A MAGNETIC FIELD. Oliver, D.; Stefanov, B. (Inst. of Electronics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 383-6(1969). (In Russian).

An exact expression is given for the electron heat conductivity of a weakly ionized plasma in a magnetic field. The expression is an exact solution for the radial heat conductivity in the case of electron-atom interactions between rigid spheres. On breaking the expression down into a series, it is possible to compare the first and second approximations with the exact solution. It is shown that if the first approximation is taken, the corresponding value of the electron heat conductivity is only 60% of the true value. (TTT)

42326 PRIGOGINE–RESIBOIS MASTER EQUATION AND PLASMA QUASI-LINEAR EQUATIONS. Rae, J. (Univ. of Texas, Austin). Physica, 42: 321-4(Apr. 21, 1969).

Classical plasma quasi-linear equations are derived from the Prigogine–Résibois master equation. (auth)

42327 UNIFIED TRANSPORT THEORY OF TWO-TEMPERATURE FULLY IONIZED PLASMAS. Daybelge, Umur (Cekmece Nuclear Research and Training Center, Istanbul). J. Phys. Soc. Jap., 27: 463-8(Aug. 1969).

The transport coefficients of a nonisothermal, fully ionized plasma have been determined without any cut-off procedure. The theory is exact in the sense that it is valid not only for large values of the Coulomb logarithms themselves but also for large values of their arguments. The effect of interactions between electrons and plasma oscillations has been incorporated in the theory. External magnetic fields have not been considered. (auth)

Production

42328 (CEA-R-3724) STUDY OF THE SYNTHESIZED PLASMA RESULTING FROM FORCED NEUTRALIZATION OF A MERCURY IONS BEAM. Spiess, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1969. 206p. Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

When an ionic beam is used (space simulation, etc.) it needs a forced space-charge neutralization by means of electron injection when the perturbations resulting from the ionic space charge are not already eliminated by the well-known self-neutralization of the beam on the background gas of the tank. It is shown that it is possible to obtain the forced neutralization of a low-energy (a few KeV) Hg^+ ion beam, 10 cm in diameter, with a neutralizer made of a hot emissive filament located inside the beam close to the ion source. The computed solution of the plane-wave dispersion equation shows that the synthesized plasma, resulting from the neutralized beam, damps fluctuations with any wave length when the average ion velocity is less than the neutralizing electron thermal velocity. This last conclusion assumes that no external electromagnetic field is applied. When a longitudinal electric field is applied, by means of a polarized grid into the beam, the plasma stability range is changed. (auth)

42329 CHAPMAN–JOUGUET SOLUTION FOR NORMAL IONIZING SHOCK WAVES IN HYDROGEN. James, B. W. (Univ. of Sydney). Phys. Lett., 29A: 509-10(July 28, 1969).

The conservation equations for a normal ionizing shock wave in hydrogen are solved with the aid of the Chapman–Jouguet hypothesis for the case in which the shock-heated plasma is completely dissociated and in Saha equilibrium. (auth)

42330 PLASMA CREATED BY LASER IRRADIATION OF SPHERICAL TARGETS. Fabre, E.; Lamain, H. (CNRS, Paris). Phys. Lett., 29A: 497-8(July 28, 1969). (In French).

The expansion in a magnetic field of a plasma created by laser irradiation of sphere of 80 μ radius presents a large flow of plasma across the field, which is explained by a partial destruction of the target. (auth)

42331 PROPERTIES OF PLASMA GENERATED BY MICROWAVE POWER AT ELECTRON CYCLOTRON RESONANCE IN A CIRCULAR WAVEGUIDE. Datlov, J.; Musil, J.; Zacek, F. (Inst. of Plasma Physics, Prague). pp 62-7 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Pulsed microwave power (0.1- to 1-msec duration) from 2-kW c-w magnetron at 2400 MHz was fed to a cylindrical waveguide. Temperature and density of the plasma were measured at the end of the waveguide by means of double Langmuir probes and a 3-cm microwave interferometer. These measurements are discussed. (M.O.W.)

42332 APPLICATION OF A STABILIZED STRONG-FLOW ARC FOR GENERATION OF AIR PLASMA AT TEMPERATURE TO 35000°K. Ershov-Pavlov, E. A.; Kiselevskii, L. I.; Shimanovich, V. D. (Minsk Inst. of Physics). Inzh.-Fiz. Zh., 16: 1101-5(June 1969). (In Russian).

On the basis of high-rate stabilized arc discharges the methods of generation of pure very hot gases suitable for the study of their optical and thermophysical parameters are developed. The maximum temperature of the air plasma at $I = 300$ A is 32,000°K. (auth)

Stability

Refer also to abstract 42289.

42333 (AEC-tr-7050) THEORY OF EQUILIBRIUM AND STABILITY OF A HIGH-CURRENT SELF-COMPRESSED DISCHARGE IN AN OPTICALLY DENSE PLASMA WITH RADIATIVE THERMAL CONDUCTIVITY. Rukhadze, A. A.; Triger, S. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17748. 53p. Dep. CFSTI.

An abstract for the original paper appeared previously in NSA 23: 12872. (M.O.W.)

42334 (COO-1695-19) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 9. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). June 15, 1969. Contract AT(11-1)-1695. 30p. Dep. CFSTI.

Theoretical work on developing an expression for the free-free bremsstrahlung from a plasma containing an anisotropic electron energy distribution was continued. The two areas under investigation are: (1) to write an energy distribution function for electrons in a plasma when the energy distribution of electrons is anisotropic and some of the electrons have relativistic velocities; (2) using this energy distribution function, calculate the free–free bremsstrahlung emission pattern from the plasma. The plasma simulation work continued with computations for the conditions of electron cyclotron resonance, periodic boundary conditions, rf confinement (no magnetic fields), and cold plasma (zero-temperature models). (M.O.W.)

42335 (IPP–3/83) EXPERIMENTAL INVESTIGATION OF THE RAYLEIGH–TAYLOR INSTABILITY OF A ROTATING HYDROGEN ARC IN AN AXIAL MAGNETIC FIELD. Doebele, H. F. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Jan. 1969. 53p. (In German). Dep.

A hydrogen arc with a hollow anode in an axial magnetic field is subjected to Rayleigh–Taylor instabilities as a result of rotation due to the radial current components at the anode. These instabilities take the form of periodic fluctuations in the light intensity emitted from the boundary regions of the arc. The modes $m = 4$ to $m = 7$, which occur in succession with increasing magnetic field, are identified by measuring the signal phases in end-on observation of the arc. The rotational velocity of the arc plasma is determined spectroscopically and comparison is made with the non-dissipative MHD theory, which yields growth rates $\sim \sqrt{m-1}$. The deviations from this theory that were observed in this experiment can be ascribed to dissipative effects. A model calculation allowing for electrical conductivity, thermal conductivity, and viscosity shows in qualitative agreement with the experiment that with increasing magnetic field the highest growth rate passes successively to the next higher mode. (auth)

42336 (IPP–3/92) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF A LOW FREQUENCY INSTABILITY IN A MODIFIED PIG DISCHARGE. Klan, F. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Apr. 1969. 71p. (In German). Dep.

A low frequency instability observed in a modified PIG discharge is identified to be a $m = 1$ distribution of the electron temperature moving approximately with the drift velocity around the discharge axis. This abnormal temperature distribution is not accompanied with a similar density distribution. The rotating zone of elevated electron temperature causes an amplitude modulation of most of the observable quantities such as floating potential of probes, discharge current and intensity of the emitted line radiation. Similar phenomena could be observed introducing periodically a small temperature perturbation in the originally stable plasma by local microwave heating. To explain the observed instability, a linear perturbation theory is developed based on the electron energy equation including appropriate source terms. From this theory a dispersion relation is obtained the real part of which gives the phase velocity of the temperature perturbation, whereas the imaginary part may be used to give a stability criterion. It is found that the phase velocity of the perturbation should be nearly equal to the drift velocity of the electron gas, and that the amplitude may grow exponentially in time if the magnetic field is sufficiently high and the neutral gas pressure is low enough. Both of these results are in good quantitative agreement with the experiments. (auth)

42337 (NP–17973) EQUILIBRIUM AND STABILITY OF PLASMA CURRENTS IN TOROIDAL SYSTEMS. Preprint No. 51. Rosinskii, S. E.; Rukhlin, V. G. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 39p. (In Russian). Dep.

Studies were made of toriodal plasma current instabilities caused by trapped and slow-emitting particles. Criteria were established for stabilizing various modes of oscillations induced by radial electric fields, longitudinal particle-current drifts, finite Larmor radii, finite drift orbits of trapped particles, and crossed lines of force in magnetic fields. It is shown that a certain channel-type instability in trapped particles can be stabilized by expansion in the case in which the magnitude of rotational transformation has the wave length maximum λ_{11} along the magnetic field lines of force shorter than the distance between the local mirrors in the magnetic field (L). In the above case, the effective fraction of trapped particles with reduced λ_{11} decreased proportionally to $(\lambda_{11}/L)^{1/2}$. Toroidal current systems and stellarator systems are compared and analyzed. (tr-auth)

42338 (UCRL–71644) UNSTABLE PULSE PROPAGATION IN AN INHOMOGENEOUS PLASMA. Hall, L. S. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 4, 1969. 4p. (CONF-690803–14). Dep. CFSTI.

From 9th International Conference on Phenomena in Ionized Gases, Bucharest, Romania.

Numerical calculations were made for the Alfven wave firehose instability, the high-density cyclotron-resonant instability, and the high-density nonresonant electron–ion instability in the limit of $j = 1$ Dory–Guest–Harris loss-cone distribution. In the cases studied, the inhomogeneous system was found to be, respectively, more unstable, little different, and more stable than the homogeneous medium with the same parameters as at $x = 0$. (M.O.W.)

42339 CRITICAL CONDITION FOR ELECTROTHERMAL INSTABILITIES. Hiramoto, T. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett., 29A: 480-1(June 30, 1969).

The critical Hall parameter β, wave vector K, and propagation speed v have been derived by the use of dispersion equations, which contain terms related to the total and local radiative loss rates and finite ionization–recombination rate α. The calculation was done in a manner similar to that performed by Kerrebrock (AIAA J., 2: 1072(1964)). (TSS) (auth)

42340 COMPUTER STUDY OF SLOW INTERCHANGE INSTABILITY IN MIRROR MACHINES. Sechovcov, V.; Kral, J.; Drska, L. (Technical Univ., Prague). pp 68-73 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The results of computer experiments studying the behavior of plasma in stationary magnetic mirror machines with respect to interchange instability are presented. The following assumptions were made: (1) the plasma is collisionless with $\beta \ll 1$, the Larmor radius being negligible; (2) instabilities conserving the magnetic moment μ and the longitudinal invariant J are considered only. (M.O.W.)

42341 EFFECT OF RESONANT PARTICLES ON THE FLUTE OSCILLATIONS OF PLASMA. Kopecky, V. (Inst. of Plasma Physics, Prague). pp 32-5 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The effect of resonant particles on the instability of flute oscillation at lesser densities than the critical density for the initiation of hydrodynamic flute instability was studied, i.e., at densities $d^2 > Ra$ where $d^2 = T/4\pi e^2 n_0$ is the Debye radius, R the radius of curvature of the magnetic field line, a the dimension of the plasma inhomogeneity, and n_0 the plasma density. (M.O.W.)

42342 GRADIENT INSTABILITIES OF COLLISIONAL PLASMA IN CURVED MAGNETIC FIELD. Jungwirth, K. (Inst. for Plasma Physics, Prague). pp 26-31 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The stabilization of collisional plasma in toroidal magnetic fields is theoretically discussed. The effect of collisions on the distribution function is taken into account in the analysis. (M.O.W.)

42343 DRIFT LOSSES IN A MAGNETIZED HELICAL GLOW DISCHARGE. Karger, F. (Institut fuer Plasmaphysik, Garching, Ger.). pp 129-33 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The drift mechanism is investigated in the stable case by inserting a right-hand glass helix in the linear section of a glow discharge device so that a helical discharge channel with an approximately kidney-shaped cross section is obtained. Electric and magnetic field measurements are discussed. (M.O.W.)

42344 PLASMA DIFFUSION AND STABILITY IN TOROIDAL SYSTEMS. Rosenbluth, M. N.; Taylor, J. B. (Inst. for Advanced Study, Princeton, N. J.). Contract AT(30-1)-3927. Phys. Rev. Lett., 23: 367-70(Aug. 18, 1969).

The problems of resistive diffusion and of rotation about the magnetic axis in toroidal systems are considered. They are shown to be related to the question of stability of drift–acoustic waves on which viscosity has an important influence. A nonrotating state is always unstable, but if the appropriate criterion is satisfied, there are stable rotating states for which an enhanced diffusion is calculated. (auth)

Thermonuclear Processes

Refer also to abstract 41161.

42345 (CONF-670846–, pp 36-57) FUSION AND PLASMAS. Dunlap, J. L. (Oak Ridge National Lab., Tenn.).

The basics of fusion research are described. Basic magnetic configurations such as mirror systems, stellarators, and the Astron concept are described. Basic plasma physics is also discussed. (M.O.W.)

42346 (EUR–3050) RAPID TRANSFER OF MAGNETIC ENERGY BY MEANS OF EXPLODING FOILS. Maisonnier, Ch.; Linhart, J. G.; Gourlan, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratorio Gas Ionizzati). 1966. 16p. (CONF-660530–13). Dep. CFSTI (U. S. Sales Only).

From 4th Symposium on Engineering Problems in Thermonuclear Research, Frascati, Italy.

Rapid transfer of magnetic energy to an inductive load, usually effected by discharging a condenser bank can, in principle, be also realized using inductive storage, the problem then being how to open quickly a switch carrying a large current. Using a thin (10 microns) cylindrical foil of aluminum as a switch, energies of the order of 10^4 joule were transferred into an inductance of about 10^{-8} henry in a time of a few 10^{-7} second. An elementary theory of the explosion of the foil is presented, and it is shown to agree well with the experimental result. Technical problems associated with the construction of such a fast switch can be considered solved up to an energy level of at least 100 kJ. (auth)

42347 (MATT-Trans–88) DESIGN OF THE TOKAMAK TM-3 DEVICE. Ivanov, D. P.; Razumova, K. A.; Us, A. M. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated for Princeton Univ., N. J., from a Russian report. 23p. Dep. CFSTI.

The TM-3 device was designed to obtain a magnetic field up to 50 kOe in magnitude with highly regular geometry. The device has the shape of a circular torus with a large radius R = 40 cm and an inside radius of the discharge chamber a_0 = 10 cm. The power system, magnet coils, and toroidal chamber are described. (M.O.W.)

42348 (NYO-3863-14) [MARK II TORUS EXPERIMENT]. Quarterly Progress Report. (Avco–Everett Research Lab., Everett, Mass.). Aug. 1969. Contract AT(30-1)-3863. 16p. Dep. CFSTI.

Efforts to improve the injection of electrons into the Mark II have continued. Increasing emphasis, however, has been placed upon the containment problems and upon problems connected with ion extraction and analysis. (M.O.W.)

42349 (ORNL-TM–2648) NEUTRONIC BEHAVIOR OF TWO FUSION REACTOR BLANKET DESIGNS. Steiner, Don (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 17p. (CONF-690901–1). Dep. CFSTI.

From International Conference on Nuclear Fusion Reactors, Culham, England.

Two fusion reactor blanket designs have been compared on the basis of their neutronic behavior. The comparison included the areas of (1) tritium breeding, (2) nuclear heating, and (3) neutron irradiation effects within the vacuum wall, i.e., neutron-induced (a) atom displacements and (b) helium and hydrogen production. The two designs investigated differed only in their assumed vacuum wall coolants; design 1 employs lithium as the vacuum wall coolant, design 2 employs lithium-beryllium fluoride (flibe) as the vacuum wall coolant. It is concluded that the neutronic behavior of a fusion reactor blanket employing lithium as the vacuum wall coolant is superior to that of one employing flibe. (auth)

42350 A CALCULATION MODEL FOR HALL-TYPE ELECTROMAGNETIC PLASMA ACCELERATORS. Junge, H. J.; Oldekop, W. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick). Luftfahrttech. Raumfahrttech., 15: 38–43 (1969). (In German).

Different acceleration mechanisms probably will be developed for magnetoplasmadynamic accelerators for second-generation space-flight devices. The principal types may be classified as thermodynamic, self-magnetic, and foreign magnetic. The limiting case of the Hall accelerator, in which thrust is achieved through Lorentz forces in an external magnetic field, is examined. Experimental results are calculated by a model calculated for a pure Hall accelerator after obtaining them on a MPD accelerator at the Institute for Plasma Physics at Braunschweig. The model gives fairly good agreement of theoretical and experimental values in spite of its simplicity, and thus conclusions about the mechanism of acceleration in MPD accelerators. One may consider devices with plasma current on the order of 200 A and magnetic induction up to 20 kG as pure Hall accelerators. Outflow velocity, efficiency, thrust, and voltage are plotted as functions of magnetic induction for comparison with experiment. (BBB)

42351 LEVITATION OF CURRENT CARRYING HOOPS OF QUADRUPOLE MAGNETIC FIELD. Kawashima, Nobuki; Mori, Sigeru (Japan Atomic Energy Research Inst., Tokai). Kaku-yugo Kenkyu, 23: No. 2, 79–86(June 1969). (In Japanese).

A simple and reliable method of levitating current-carrying hoops for a quadrupole magnetic field is presented. The hoops are initially supported by three supports, and the supports are forced down by a magnetic coil excited by a capacitor bank leaving the current-carrying hoops floating in space for more than 10 msec. The reproducibility is perfect and no damage nor deformation of material is observed. A preliminary experiment on the plasma injection without the effect of supports is described, and the possibility of levitation for a thermonuclear reactor by using a weightless system is also discussed. (NSA of Japan)

Wave Phenomena

Refer also to abstracts 42227, 42235, 42297, and 42334.

42352 (AEC-tr–7054) STUDIES OF QUASI-STEADY ELECTRIC FIELDS AND PLASMA OSCILLATIONS IN A STEALLARATOR L-1. Berezhetskii, M. S.; Grebenshchikov, S. E.; Kossyi, I. A.; Nechaev, Yu. I.; Rabinovich, M. S.; Sbitnikova, I. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP–17762. 19p. Dep. CFSTI.

An abstract for the original paper appeared earlier in NSA 23: 14740. (M.O.W.)

42353 (AEC-tr–7078) ON THE THEORY OF PARAMETRIC INTERACTION OF A SUPERHIGH FREQUENCY FIELD WITH A PLASMA. Silin, V. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Preprint No. 22. 20p. Dep. CFSTI.

Equations have been developed describing the evolution of the distribution of particles and of an unbalanced field in a turbulent state of plasma, developing during the parametric effect of a powerful superhigh frequency field. The application of the theory to the case of the kinetic instability of the non-isothermal plasma, caused by the Cherenkov effect on the electrons, indicates an anomalous increase in the dissipative high-frequency conductivity of the plasma, associated with the increase in the intensity of the plasma oscillations. (auth)

42354 (SIT–3785-9) INVESTIGATIONS IN PLASMA DYNAMICS. Annual Progress Report. Schmidt, George (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). July 1969. Contract AT(30-1)-3785. 11p. (SIT–239). Dep. CFSTI.

Nonlinear wave–particle interaction in a transverse wave propagating along a uniform magnetic field was investigated. Minor studies on adiabatic invariants and magnetically confined electron plasmas were also made. (M.O.W.)

42355 KINETIC THEORY OF ACOUSTIC WAVE PROPAGATION IN PLASMA. Asrorov, A. (Inst. of Physics and Tech., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR, 12: No. 4, 23-6(1969). (In Russian).

Propagation of acoustic waves in a completely ionized two-component plasma was studied, using the Landau–Vlasov kinetic equations that take into account collective interactions and particle collisions. It is shown that acoustic waves propagating in a completely ionized plasma excited high-frequency "electron acoustics" and, in addition, low-frequency "ion acoustics." (R.V.J.)

42356 RESONANTLY SUSTAINED BOUNDED RADIOFREQUENCY PLASMA IN A SPHERICAL CAVITY. Messiaen, A. M.; Vandenplas, P. E. (Laboratoire de Physique des Plasmas, Brussels). Appl. Phys. Lett., 15: 30-3(July 1, 1969).

It is shown that the low-power linear behavior of a cavity (here a spherical one) partially filled with plasma plays a fundamental role in understanding the formation of an rf plasma inside it a higher power levels. The rf plasma is found to be sustained in one of the linear resonant states of the system. With moderate rf power (10 to 100 W), it is possible to sustain bounded plasmas in the cavity having densities far above the critical one. The value of the density depends, as is theoretically predicted, essentially on the frequency and only slightly on the power level of the exciting signal. (auth)

42357 COLLISIONAL DAMPING OF WAVES IN PLASMAS. McBride, John Barton. Hanover, N. H., Dartmouth Coll., 1969. 118p.

Thesis.

The collisional damping of small-amplitude, electron waves in fully ionized Maxwellian plasmas is considered. Dispersion relations, and collisional damping rates are derived for the longitudinal plasma oscillation, linearly polarized transverse mode, and circularly polarized modes using the Landau equation, and its relativistic generalization, the Belyaev–Budker equation. In Chapter II the treatment is nonrelativistic. In Chapter III relativistic effects are included to lowest order by treating the electrons relativistically. The calculations are done for no external fields, and then for a uniform magnetic field, $\underset{\sim}{B}_0$. The results include first order thermal corrections, and products of thermal by relativistic corrections are neglected. The procedure is to evaluate the electron current density using an approximate solution ($\underline{F}_1$) to the linearized kinetic equation. Where more convenient, an equivalent moment equation approach is used with the aid of $\underline{F}_1$. (Diss. Abstr.)

42358 AN EXPERIMENTAL INVESTIGATION OF THE ION–ION HYBRID RESONANCE. Baird III, Albert Washington. Austin, Tex., Univ. of Texas, 1968. 61p.
Thesis.

An experiment is described in which the ion–ion hybrid resonance is observed and studied. The theory of a cool, partially ionized plasma in a magnetic field is given, and dispersion characteristics of a wave launched in a bounded two-ion species plasma near the resonance is investigated. Computer results showing the behavior of the attenuation coefficient of the launched wave as a function of density, magnetic field, resistivity, density ratio of the ions, and frequency are given. The apparatus is described. The attenuation coefficient has been measured for a variety of plasma conditions; these data have been fitted to the predicted theory with generally good agreement. (Diss. Abstr.)

42359 PROPAGATION CHARACTERISTICS OF DRIFT WAVES IN AN INHOMOGENEOUS MAGNETOPLASMA. Nishida, Y.; Tanibayashi, M.; Sato, T.; Ishii, K. (Nagoya Univ., Japan). Phys. Lett., 29A: 455-6(June 30, 1969).

Propagation characteristics of electrostatic drift waves excited by means of a pair of plates with some arbitrary frequency show the cutoff at the frequency of spontaneous diamagnetic drift wave. (auth)

42360 SLIGHT DISPERSION WAVES IN A DISCHARGE IN CO_2-O_2 MIXTURES. Exner, V. L.; Pekarek, L. (Inst. of Physics, Prague). pp 223-8 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.
See CONF-681053.

The possible connection of dispersion waves is studied in CO_2–O_2 mixtures, together with the changes of the curious jump in the current and the longitudinal electric field known in oxygen plasma as a transition from a high to low electric field. (M.O.W.)

42361 NONLINEAR WAVE TRANSFORMATIONS IN PLASMAS (KINETIC AND HYDRODYNAMIC THEORY). Sauer, K. (Physikalisch-Technisches Institut, Berlin). pp 40-5 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.
See CONF-681053.

The second-order coupling effects discussed in the literature, but not sufficiently treated for magnetoactive plasmas are described in unified and clear form. A nonlinear third-rank tensor of conductivity is used, with which any primary fields corresponding to the different (linear) wave modes can be connected. The calculation of the tensor components is done with the aid of the hydrodynamic and kinetic theory. Especially, plasma wave echoes can be described by the obtained formalism, in which the coefficient responsible for the interaction of longitudinal waves must be determined by the kinetic calculation. For isotropic plasmas, the interaction of longitudinal (L) and transverse (T) waves yields the following transformations: LT–T (scattering of EM waves on density of fluctuations), TT–L (excitation of plasma oscillations by transverse waves), LL–T (conversion of longitudinal into transverse waves), LT–L (scattering of longitudinal on transverse waves) and LL–L (plasma wave echoes). The transformations for primary waves propagating parallel and perpendicular to the magnetic field are compiled in a survey. (auth)

42362 ELECTROSTATIC OSCILLATIONS IN COLD INHOMOGENEOUS PLASMAS. Sedlacek, Z. (Inst. of Plasma Physics, Prague). pp 36-9 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.
See CONF-681053.

The Laplace transform technique was used to study small amplitude electrostatic oscillations in a cold plasma with continuously varying density. A Green function analysis was also used. (M.O.W.)

42363 INVESTIGATION OF SPATIAL DISTRIBUTION OF ELECTROMAGNETIC WAVES, EXCITED IN THE PLASMA-BEAM DISCHARGE NEAR TO THE ELECTRON CYCLOTRON HARMONIC FREQUENCIES. Lukinov, I. N.; Basharinov, A. E.; Zalogyn, N. N.; Kislov, V. Ya. (Inst. of Radiotechnique and Electronics, Moscow). pp 13-18 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.
See CONF-681053.

An experimental study was made of the oscillations at frequencies $\omega > \omega_c \sim \omega_p$ excited in beam–plasma discharge in the presence of a longitudinal magnetic field. Results are given for studies on the intensities of the oscillations excited near different harmonics of electron cyclotron frequency, their spatial increments, and the wave numbers and other characteristics that help to develop the conceptions on the beam–plasma interaction nature. (M.O.W.)

42364 SHEATH ECHOES OF ION-ACOUSTIC WAVES IN A DC-DISCHARGE PLASMA. Sugie, H.; Sato, N. (Tohou Univ., Sendai). Phys. Lett., 29A: 525-7(July 28, 1969).

An experimental observation was made of echoes of ion–acoustic waves due to reflection of ions in front of an anode of dc discharge. (auth)

42365 NONLINEAR EXCITATION BY MODULATION OF NEW ION RESONANCES IN BOUNDED MAGNETIZED PLASMAS. Messiaen, A. M.; Vandenplas, P. E.; Monfort, J. -L. (Ecole Royale Militaire, Brussels). Phys. Lett., 29A: 573-4(July 28, 1969).

The microwave field creating a resonantly sustained bounded plasma is amplitude modulated at a lower frequency. Nonlinear interaction leads to the observation of new resonances in the magneto-ion domain. This constitutes a new method of coupling energy to the ions. (auth)

42366 EXPERIMENTAL DRIFT-WAVE DISPERSION CURVE FOR A HELIUM MAGNETOPLASMA. Keen, B. E.; Aldridge, R. V. (Culham Lab., Abingdon, Eng.). Phys. Lett., 29A: 575-6 (July 28, 1969).

Results are presented that support the general shape of the dispersion curve for drift waves as predicted using the "two-fluid" equations. (auth)

42367 FREQUENCY SHIFT OF NONLINEAR ELECTRON PLASMA OSCILLATIONS. Bertrand, P. (Univ., Nancy); Bauman, G.; Feix, M. R. Phys. Lett., 29A: 489-91(July 28, 1969).

The frequency shift of the nonlinear plasma oscillations, consequence of the interaction between nonlinear and thermal effects, is computed by application of the Krylov–Bogolyubov perturbation method to the Lagrangian equations of the "water bag" model for collisionless electron plasma. (auth)

42368 NONLINEAR AND COLLISIONAL EFFECTS ON LANDAU DAMPING. Doyle, Brian Webster. Evanston, Ill., Northwestern Univ., 1968. 61p.
Thesis.

In the collisionless case, nonlinear effects considerably reduce Landau damping after a time of the order of the period of oscillations of trapped electrons. A perturbation analysis of the nonlinear Vlasov equation, modified by the addition of a simplified Fokker–Planck collision term, is carried out following Montgomery's expansion technique. The modified Landau poles for Maxwellian plasmas are determined. The first and second order number densities and the second order spatially homogeneous distribution function are evaluated in terms of the collision parameter β, wavelength λ and initial amplitude ϵ. The competing effects of nonlinearities and collisions on the formation of a plateau in the spatially homogeneous distribution function are studied. Values of β which prevent the formation of the plateau and maintain Landau damping close to the value prescribed by the linear theory are determined. (Diss. Abstr.)

42369 RESONANT ELECTRON EFFECTS ON NONLINEAR OSCILLATIONS IN A COLLISIONLESS PLASMA. Bailey, Vernon Leslie Jr. Evanston, Ill., Northwestern Univ., 1968. 86p.
Thesis.

The damping of collisionless plasma oscillations depends on the parameter α_s/γ_L where γ_L is the absolute value of the Landau damping constant and α_s is the small amplitude frequency of electrons in the potential trough of the initial electric field. For $\alpha_s/\gamma_L \ll 1$ Landau damping is sufficiently strong to damp the wave before the electrons have had enough time to shift significantly in the resonance region and the linear theory applies. In the strongly nonlinear case, $\alpha_0/\gamma_L \gg 1$, the amplitude of the wave decreases slowly in relation to the natural period of oscillation of an electron in the potential trough of the wave. In this case the electrons in the resonant region shift significantly and may contribute to the regrowth of the wave. Previous solutions by O'Neil, and Al'tshul and Karpman have considered only the limiting case where α_0/γ_L becomes infinite, and the wave has only an infinitesimal amplitude modulation. The solution presented in this dissertation applies to large but finite values of α_0/γ_L for which Landau damping is not completely negligible, and the wave is allowed to have a finite amplitude modulation. An approximate solution of the Vlasov equation is obtained by expanding the electron position and velocity in powers of $\dot{\alpha}/\alpha^2$ where $\alpha(t) = \sqrt{e\epsilon(t)m/k}$ with k the wavenumber and $\epsilon(t)$ the amplitude of the electric field. Energy conservation is used to obtain an expression for $\alpha(t)$. Numerical results are obtained for several values of γ_L/α_0. As the nonlinearity is decreased (α_0/γ_L becomes smaller) the electric field amplitude follows the linear theory for a longer time. (Diss. Abstr.)

42370 INDUCED SCATTERING AND DISINTEGRATIONS OF ELECTRON–ACOUSTIC OSCILLATIONS IN PLASMA. Sizonenko, V. L.; Stepanov, K. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 935-44(June 1969). (In Russian).

Induced scattering and disintegrations of electron-sound oscillations are considered of plasma with hot ions and cold electrons, the oscillations propagating almost perpendicularly to an external magnetic field. Matrix elements are found determining probability of these processes for wave packets representing a set of waves with arbitrary phases. Expressions are obtained for nonlinear additions to the oscillation frequency and nonlinear damping decrement. Disintegration of an electron-sound wave with a fixed phase into two electron-sound waves is considered. (auth)

42371 FLUCTUATIONS IN CONFINED PLASMAS. II. FLUTE MODES INDUCING PARTICLE DIFFUSION IN PLASMAS WITH $T_e \geq T_i$. Coppi, B. (Inst. for Advanced Study, Princeton, N. J. Princeton Univ., N. J.). Phys. Rev., 184: 130-4(Aug. 5, 1969).

Collisionless plasmas in which the electron temperature is higher than or of the order of the ion temperature are shown to be subject to overstable flute modes, associated with the electron curvature drift, when the magnetic curvature is periodically varying along the lines of force and its average is sufficiently smaller than its rms value (i.e., the magnetic well is shallow). The relevant modes have a growth rate larger than the average ion excursion frequency along the magnetic field lines and transverse wavelengths larger than the ion Larmor radius, so that sizable anomalous particle transport can be expected of them, in consistence with the observations. (auth)

42372 THEORY OF PARAMETRIC INTERACTION BETWEEN AN ULTRAHIGH FREQUENCY FIELD AND PLASMA. Silin, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 57: 183-95(July 1969). (In Russian).

Equations are formulated which describe the evolution of the particle distribution and of the nonequilibrium field in a turbulent plasma created by parametric action of a strong ultrahigh frequency field. Application of the theory in the case of kinetic instability of a nonisothermal plasma due to the Cherenkov effect for electrons indicates an anomalous increase of dissipative high frequency conductivity of the plasma related to increase of intensity of the plasma oscillations. (auth)

42373 THEORY OF LOW FREQUENCY ELECTROMAGNETIC PROPERTIES OF A TURBULENT PLASMA. Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 57: 141-56(July 1969). (In Russian).

A theory of linear low frequency electromagnetic waves and instabilities in a turbulent plasma is developed and it is shown that the electromagnetic properties of the plasma significantly change in the region of low frequencies which are much smaller than the effective frequencies of turbulent collisions. An approach is developed which is based on expansion of the plasma particle and turbulent pulsation collision integrals into the turbulency energy. This approach shows that in an isothermal turbulent plasma if the turbulency energy W exceeding the critical value W_{cr}($W_{cr} \ll nT$) ion sound type wave may propagate whose speed depends on the turbulency energy. The conditions of applicability of the approach based on expansion of the turbulent collision integrals in terms of the turbulence energy are elucidated. These conditions impose rigid conditions on the possibility of manifestation of instabilities of the longitudinal (potential) perturbation in the turbulent plasma. A new approach for evaluation of the particle and turbulent pulsation collision integrals is developed which is based on taking into account weakness of correlation of turbulent pulsations and of correlation between the pulsations and perturbations of the turbulent pulsations. An integral equation is derived and solved which permits one to sum the series in turbulence energy in the indicated collision integrals. It is shown that the result is the renormalization of the plasmon Green function and particle charge related to nonlinear modification by turbulency the dispersive properties of the turbulent pulsations. The dielectric constant derived is employed for investigating new instabilities of longitudinal perturbations in a turbulent plasma. (auth)

42374 OBLIQUE INCIDENCE OF ELECTROMAGNETIC WAVE ON PARABOLIC PLASMA LAYER. Smilyanskii, V. R. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 27-33(May-June 1969). (In Russian).

The oblique incidence of harmonic electromagnetic waves with electric vectors distributed along the plane of incidence on a parabolic surface of plane-laminated isotropic plasma was investigated. Reflection and penetration coefficients and coefficient of electromagnetic wave transformation into a plasma wave were obtained. (tr-auth)

42375 NONLINEAR THEORY OF HIGH-FREQUENCY HYBRID RESONANCES IN A NONUNIFORM PLASMA. Demchenko, V. V.; Stepanov, K. N. (Kharkov State Univ.). Ukr. Fiz. Zh., 14: 1023-31(June 1969). (In Russian).

The propagation of electromagnetic waves is considered in a weakly nonuniform plasma where wave frequency is equal to the hybrid one. The amplitude of the electronic oscillations in a resonant region is shown to be not limited by nonlinear terms $(\vec{v}\nabla)\vec{v}$ in the motion equations. Nonlinear terms, which are due to nonuniformity of the density, can limit the oscillation amplitude. However, when the oscillation amplitudes are very large, self-crossing of the electron traces arises. (auth)

Shielding

42376 (CONF-690609–7) NEUTRON AND GAMMA-RAY SPECTRA IN AN IRON SPHERICAL ASSEMBLY. Cerbone, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). [1969]. 19p. Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

The neutron angular flux spectra from 1 keV to 10 MeV and the gamma-ray spectra and its associated time dependence were measured. The spatial- and angular-dependent neutron spectrum in a 76.2-cm-diameter steel sphere was measured using conventional time-of-flight techniques. The gamma-ray spectrum measurements were primarily a feasibility study to show that these measurements can be made in a bulk assembly. (M.H.R.)

42377 (FOA-4-4393) SURVEY OF METHODS FOR VARIANCE REDUCTION IN CALCULATION OF UNCHARGED PARTICLES TRANSPORT BY MONTE CARLO TECHNIQUE. Fraeki, R. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). July 1969. 15p. (In Swedish). Dep.

Methods for variance reduction in Monte Carlo treatments of transport of uncharged particles are reviewed. Emphasis is put on methods for shielding calculations. The multiple scaling with optimal learning method by S. B. Layno is described in some detail. Effects on flow and spectrum estimation are discussed. (Sweden)

42378 (HASL-205) EXPERIMENTAL AND THEORETICAL STUDIES OF THE TRANSPORT OF GAMMA-RAYS THROUGH SLAB SHIELDS. Bennett, Burton G.; Burke, Gail deP.; Beck, Harold L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 1969. 46p. Dep. CFSTI.

The penetration of gamma rays through slab shields has been investigated in considerable detail by theoretical calculations using Monte Carlo and polynomial expansion methods and by experimental measurements using a collimated NaI(Tl) spectrometer system. Special attention was given to a 2 mfp Al slab with a 0.662 MeV (^{137}Cs) gun source normally incident for which Monte Carlo calculations were made of the angular spectra of gamma rays emerging from the total slab area and those from a small central region on the exit side of the slab. The latter calculation corresponded closely to the experimental situation in which the angular spectra were measured at 11 angles from the normal to the 2 mfp Al slab. The close correlation between calculation and experiment was useful in substantiating the validity of the theoretical and experimental techniques. The Monte Carlo calculations were performed for the lateral as well as transverse transport of gamma rays passing through slab shields. Information was obtained on the lateral attenuation of transmitted energy, flux, and exposure for the 0.662 MeV gamma gun source normally incident on 1, 2, 3, and 4 mfp Al, concrete, and Fe slabs. The differential energy spectra of transmitted scattered gamma rays obtained for these materials and thicknesses were compared to the results obtained using our low order DP1 polynomial expansion method. The two theoretical methods showed very close general agreement. The theoretical and experimental results obtained from these investigations of gamma transport in slab shields provide reliable basic gamma shielding information. (auth)

42379 (ORNL-tr-2178) STUDY OF THE ENERGY AND ANGULAR DISTRIBUTION OF ELECTRONS BEHIND BARRIERS OR DIFFERENT THICKNESS. Kononov, B. A.; Gusev, E. A. Translated for Oak Ridge National Lab., Tenn., from Izv. Vyssh. Ucheb. Zaved., Fiz., 19: 147-9(1968). 4p. Dep. CFSTI.

Plotted data are presented to show the angular distribution of electrons after penetrating thin Be and Cu targets and the energy distribution after penetrating thick C targets. Target thicknesses and incident betatron beam energies were: Be−t = 2.26 mg/cm^2, E = 2.91 MeV; Cu−t = 1.7 mg/cm^2, E = 2.91 and 5.89 MeV; C−t = 0.53, 1.25, and 1.78 g/cm^2, E = 2 to 6.6 MeV. Agreement between experiment and theory was within 5% for Cu, but for Be the measured value was twice the calculated value. For the thick C targets the theory of Moliere describes well the electron distribution when energy losses are less than 10% of the initial energy, but the theory does not hold when energy losses exceed 10%. (D.E.B.)

42380 GAMMA RADIATION FROM Li, C, Mg, Al, Ni, Zn, Zr, Ag, Ta, Au, AND Pb TARGETS BOMBARDED BY 42-MeV ALPHA PARTICLES. Omarov, S. S.; Daruga, V. K.; Matusevich, E. S.; Prokhorov, S. S. At. Energ. (USSR), 26: 390(Apr. 1969). (In Russian).

The targets had a diameter of 30 mm and a thickness of about 1.5 mean free paths of the incident 42-MeV alpha particles. The secondary gamma radiation was measured on a scintillation counter with a stilbene crystal 30 × 20 mm. The dose of the secondary gamma radiation is given in rads. m^2/alpha particle at angles of zero, 45, and 90° to the incident alpha beam. Estimates are given for values of the average energy carried off by the gamma quanta per single inelastic interaction of the alpha particles in the target. The accuracy of the estimate does not exceed 50%. The average energy does not depend on the type of incident particle or its energy. (TTT)

42381 GAMMA RADIATION FROM Li, C, Al, Ni, Cu, Nb, Cd, Ta, AND Pb TARGETS BOMBARDED BY 21-MeV PROTONS. Omarov, S. S.; Daruga, V. K.; Matusevich, E. S.; Prokhorov, S. S. At. Energ. (USSR), 26: 388-9(Apr. 1969). (In Russian).

It is difficult to obtain differential cross sections for the formation of gamma quanta, but the adsorbed dose in a shield whose thickness is greater than the ionization range of the proton can be readily determined. Thus, gamma doses were measured from targets with a thickness of 1 g/cm^2 and a diameter of 30 mm irradiated with 21-MeV protons. The gamma radiation was counted on a scintillation detector with a stilbene crystal 30 × 20 mm at angles of zero, 45 and 90° to the proton beam. The electronics circuit permitted counting of gamma rays in the presence of neutrons. The dose is in rad. m^2/proton. If the dose D is known, it is possible to estimate approximately the average energy given off by all the gamma rays during an inelastic nuclear interaction of the proton and target atom. This average energy does not depend on the atomic number of the target atoms or on the initial energy of the proton. Thus it is possible to estimate the secondary radiation dose from thin shields of average or high atomic number. The estimated dose is within a factor of two of the actual dose. (TTT)

42382 STSINTILLYATSIONNYE SPEKTRY RASSEYANNOGO GAMMA-IZLUCHENIYA TOCHECHNYKH ISTOCHNIKOV. (Scintillation Spectra of Scattered Gamma-Radiation from Point Sources). Artsybashev, V. A.; Ivanyukovich, G. A. Moscow, Atomizdat, 1969. 108p.

More than 370 dispersed gamma spectra of point sources in different media are presented. (TSS) (auth)

Solid-State Physics

42383 (CONF-681210-(Vol.3)) PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, BOMBAY, DECEMBER 28–31, 1968. VOLUME III. SOLID-STATE PHYSICS. (Department of Atomic Energy, Bombay (India). Physics Committee). 1968. 517p.

Copies of over one hundred papers presented at the conference are included. Separate abstracts were prepared for 10 papers. (M.C.G.)

For abstracts of individual papers see: 42200, 42445−42450, and 42494−42496.

42384 DIRECT EVIDENCE OF DIVACANCY FORMATION IN SILICON BY ION IMPLANTATION. Stein, H. J.; Vook, F. L.; Borders, J. A. (Sandia Labs., Albuquerque, N. Mex.). Appl. Phys. Lett., 14: 328-30(May 15, 1969).

The production of divacancies in Si by 400-keV oxygen ion implantation ($\Phi_I = 1.75 \times 10^{14}$ cm^{-2}, two sides) was detected by the characteristic divacancy optical absorption band at 1.8 μ. This band has been previously correlated with the presence of divacancies in electron- and neutron-irradiated silicon. Ion-produced divancy annealing near 200°C was observed to correlate with neutron-produced divacancy annealing. Detailed comparisons of the annealing of electron-, neutron-, and ion-produced divacancies suggest that the ion-produced divacancies anneal primarily in regions with sink concentrations $\geq 10^{19}$ cm^{-3}. (auth)

42385 ANNEALING CHARACTERISTICS OF n-TYPE DOPANTS IN ION-IMPLANTED SILICON. Crowder, B. L.; Morehead, F. F. Jr. (IBM Watson Research Center, Yorktown Heights, N. Y.). Appl. Phys. Lett., 14: 313-15(May 15, 1969).

Investigations of the conditions under which the donors, P, As, and Sb, are incorporated into Si by ion implantation (260−300 keV) in an electrically active form are reported. Above a critical dose, room-temperature implantations followed by a 600°C post anneal are substantially more effective than implantations at 600°C. (auth)

42386 CONDUCTIVITY AND HALL MOBILITY OF ION-IMPLANTED SILICON IN SEMI-INSULATING GALLIUM ARSENIDE. Sansbury, James D.; Gibbons, James F. (Stanford Univ., Calif.). Appl. Phys. Lett., 14: 311-13(May 15, 1969).

Chromium-doped semi-insulating gallium arsenide was successfully doped n-type by ion implantation of silicon. Studies are presented which show that at annealing temperatures in excess of 600°C, conductivity and Hall mobility rise to values comparable to those expected for heavily doped gallium arsenide. (auth)

Radiation Effects

Refer also to abstracts 40578 and 41184.

42387 (AD-679694) CERTAIN MODELS OF RADIATION DEFECTS IN NONCONDUCTING CRYSTALS. Kiv, A. E.; Starodubtsev, S. V. Translated by F. Dion from Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 3, 41-3(1963). 7p. (FTD-HT-23-222-68). CFSTI.

A brief continuation of another document that discussed the mechanisms of the displacement of atoms in valence crystals during ionization of the inner shells of two adjacent atoms is presented. Application to electron optics is indicated. (USGRDR)

42388 (AD-682530) INVESTIGATION OF LITHIUM INTERACTIONS IN IRRADIATED SILICON BY EPR MEASUREMENTS. Final Report, November 1, 1967–July 31, 1968. Goldstein, Bernard (Radio Corp. of America, Princeton, N. J. RCA Labs.). Aug. 1968. Contract F19628-68-C-0133. 40p. (AFCRL-68-611). CFSTI.

Silicon, both with and without oxygen, was diffused with Li to concentrations of 10^{16} and 10^{17}/cm^3 and was bombarded with 1-MeV electrons. The ensuing defects were studied by electron paramagnetic resonance and electrical measurements. Oxygen strongly affects the properties of these defects. (auth) (USGRDR)

42389 (CEA-R-3668) CONTRIBUTION TO THE STUDY OF DEFECTS CREATED BY α PARTICLES IN URANIUM AT 4.2°K. Raharinaivo, Andre L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1969. 84p. Dep. (In French).

Thesis. Submitted to Univ. of Nancy, France.

A device is described for the irradiation, in liquid helium, of metallic strips with α particles produced by radioactive sources. It was thereby possible to measure changes in resistivity of variously treated uranium samples (cold-worked, annealed, previously exposed to neutrons, etc.) as a function of the irradiation flux. The annealings carried out after irradiation compare favorably to those affected after a quenching from 100 to 4°K. The results are discussed; it is concluded that a defect, very probably of the interstitial type, is mobile in uranium at temperatures below 5°K. (auth)

42390 (COO-1054-42) ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIATION EFFECTS IN SOLIDS AND CHEMICAL COMPOUNDS. Technical Progress Report, June 1, 1968–May 31, 1969. Kim, Yeong Wook (Wayne State Univ., Detroit, Mich. Dept. of Physics). June 9, 1969. Contract AT(11-1)-1054. 20p. Dep. CFSTI.

The delayed luminescence of single crystals subjected to extremely weak radiation treatments at controlled temperatures was investigated. Results showed that the delayed luminescence in the very early stage of radiation-defect formation is quite distinct from the direct luminescence observed in the F to M conversion by F-bleaching. It is postulated that delayed luminescence may have something to do with positive ion vacancies (α centers). Systematic investigations were made of direct luminescence of calcium tungstate under sustained x-irradiation, thermal luminescence following the x-irradiation at 77°K, and possible photoconductivity during irradiation. Three study programs on superconducting materials are being carried out. One of them deals with microwave interactions of type II superconducting materials in the mixed state, the second with electron tunneling properties through superconducting junctions, and the third with dc interactions of type II superconducting materials. These studies are being conducted with controlled x-irradiation near cryogenic temperatures. (M.C.G.)

42391 (COO-1494-6) CONCENTRATION DEPENDENCE OF FRENKEL PAIR DEFECT ANNEALING IN ELECTRON IRRADIATED Ta AND Nb. Myhra, Sverre; DeFord, John W. (Utah Univ., Salt Lake City. Dept. of Physics). [1968]. Contract AT(11-1)-1494. 34p. Dep. CFSTI.

The dose dependence of the annealing spectra of Ta and Nb from 15 to 285°K after bombardment with 2.2-MeV electrons were investigated. Ta and Nb samples were irradiated to different defect concentrations, then simultaneously annealed isochronally from 14.7 up to 285°K. In Ta recovery peaks were observed at 23, 51, 65, 123, and 170°K. The position of the peak near 170°K is dose dependent and shows the characteristics of a second-order reaction. In Nb recovery peaks were observed at 26.5, 58, 95, and 135°K. The peak at 95°K is dose dependent and follows second-order kinetics initially with an apparent shift to higher order toward the end of the stage. A two-interstitial model seems to give the best fit to the data. (auth)

42392 (COO-1494-7) THRESHOLD DISPLACEMENT ENERGY MEASUREMENTS ON Ta AND Nb. Youngblood, G.; Myhra, S.; DeFord, J. W. (Utah Univ., Salt Lake City. Dept. of Physics). [1968]. Contract AT(11-1)-1494. 30p. Dep. CFSTI.

Changes in the damage rate (residual electrical resistivity per unit electron fluence) were measured as a function of incident electron energy in the range from 1.0 to 2.2 MeV for 0.002-in.-diameter Nb and Ta wires. The threshold energies, estimated by simple extrapolation to zero production rate, were 36 eV for Nb and 32 eV for Ta. The resistivity of a Frenkel pair was determined to be about 5.3 $\mu\Omega$-cm/at.% for Nb and 1.9 $\mu\Omega$-cm/at.% for Ta. The damage production curves for two other bcc metals, Mo and W, were compared to the Nb and Ta production curves. (auth)

42393 (COO-1807-1) PROGRESS REPORT ON [ESR STUDIES ON TRAPPED SPECIES IN IRRADIATED SOLIDS]. Hamlet, Peter L. (Kansas Univ., Lawrence. Dept. of Chemistry). May 20, 1969. Contract AT(11-1)-1807. 5p. Dep. CFSTI.

Progress is reported on electron spin resonance studies on trapped species in irradiated solids. Frozen solutions of saturated alcohols were bombarded with H atoms at 77°K and the reactions monitored by ESR. Spatial distributions in calcium ion and silver ion doped alkali halide crystals were studied. Yields of F centers in the Ca^{2+}-doped material were too low to be significant. Saturation measurements on γ-irradiated silver-ion-doped KCl indicated an inhomogeneous distribution of Ag atoms with the radius of the average spur being about 80 Å. Results indicated that the first optically allowed excited state of the trapped electron in irradiated 10$\underline{M}$ NaOH and glassy methanol at 77°K is weakly bound, if at all. (J.G.B.)

42394 (N-69-22194) SPECTROGRAPHIC STUDIES OF LUMINESCENCE IN CHARGED-PARTICLE-IRRADIATED OPTICAL MATERIALS. Final Report. Romanko, John; McDaniel, R. H.; Miles, J. K.; Cheever, P. R.; Massingill, G. S. (General Dynamics/Fort Worth, Tex.). Mar. 21, 1969. Contract NAS1-7734. 152p. (NASA-CR-66758; FZK-364). CFSTI.

The spectral luminescence induced in optical glasses and quartzes by high-energy charged particles was measured in the wavelength range from 300 to 650 nanometers (nm) utilizing a grating spectrograph of 0.5 nm resolution. Electron energies were 1, 2, 3, 5, 10, and 20 MeV; proton energies were 1, 2, and 3 MeV. Fluxes were from 2.5×10^{11} to 5×10^{13} particles/cm^2-sec. The induced luminescence varied from a few tenths to 100 nanowatts/cm^2-steradian-nm in the visible region. Only the luminescence of the quartzes was linear with flux and absorbed dose of 1, 2, and 3 MeV electrons. (auth) (STAR)

42395 MAGNETIC IMPURITIES IN NONMAGNETIC MATERIALS. Abrikosov, A. A. (Inst. of Theoretical Physics, Moscow). Usp. Fiz. Nauk, 97: 403-27(Mar. 1969). (In Russian).

Small amounts of transition metals added to a nonmagnetic metal may affect greatly the properties of the latter, regardless of the concentration of the impurity; in some cases, the electron heat capacity at low temperatures was increased several fold, in others, the thermo-emf was increased by several orders of magnitude. This is attributed to the fact that the atoms of the transition metals possess unfilled d or f shells and other-than-zero electron spins, conserving these properties when being admixed to nonmagnetic metals. Many phenomena are related to the presence of impurity atoms with localized spin. The problem may be represented in the form of a symmetric matrix, covering ordering, superconductivity, and the Kondo effect. The interaction between localized spins and electrons leads ultimately to the interaction of spins with each other. These phenomena are examined in detail, examining also the effect of impurities on the critical temperature. 62 references. (TTT)

42396 THE RELATIVE IMPORTANCE OF α-CENTRE AND V_k-CENTRE MOTION IN THE INHIBITION OF F-CENTRE PRODUCTION BY IMPURITIES. Dawson, R. K.; Pooley, D. (Atomic Energy Research Establishment, Harwell, Eng.). Solid State Commun., 7: 1001-4(July 1969).

The dependence on temperature of F-center production by electron irradiation in KCl : Pb and KI : Tl was examined in the range 125 to 300°K. The inhibition of coloration caused by the electron trapping impurities is compared with that expected for two possible inhibition mechanisms, depending respectively on a reduced formation rate for F centers and an enhanced destruction rate. The experiments are shown to favor the first possibility strongly. (auth) (UK)

42397 ION-INDUCED ELECTRON EJECTION FROM A GAS-COVERED TUNGSTEN SINGLE CRYSTAL. Couchman, D. L. V.; Burtt, R. B. (King's Coll., London). J. Phys., D (London), 2: 1177-9(Aug. 1969).

Positive-ion beams of neon, argon and krypton gases with kinetic energies between 1 and 4 keV and a small convergent angle were used to measure the angular dependence of positive-ion—electron ejection from a ⟨100⟩ face of a contaminated tungsten crystal. Pronounced drops in the value of γ for changes of less than 1° in the incident angle were observed. (auth) (UK)

42398 TRANSMISSION OF ENERGETIC PROTONS THROUGH VERY THIN CRYSTALS. Chadderton, Lewis T.; Eisen, Fred H. (North American Rockwell Corp., Thousand Oaks, Calif.). Phil. Mag., 20: 195-200(July 1969).

Experiments concerning the transmission of 400 keV protons through crystals of gold 200 to 300 Å thick are described. The patterns observed are dominated by the channelled component for perpendicular incidence. Angular widths are greater than would be expected on the basis of the Lindhard (1965) theory. Multiple scattering is shown to be separable into nuclear and electronic components. (auth) (UK)

42399 NONSTEADY-STATE RADIATION DIFFUSION IN METALS. Bystrov, L. N.; Ivanov, L. I.; Platov, Yu. M. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR, 185: 309-12 (Mar. 11, 1969). (In Russian).

The radiation increase of diffusion in metals is due mainly to an increase in concentration of point defects during irradiation. Equations are given for the kinetics of annealing of radiation defects with dislocation movement and mutual annihilation of vacancies and interstitial atoms being taken into account. In metals it is generally assumed that the mobility of interstitial atoms is substantially greater than the mobility of vacancies. If diffusion is studied at temperatures where the interstitial atoms are mobile and the vacancies can be considered as not mobile, part of the interstitial atoms introduced by irradiation will be annihilated by dislocations, and the corresponding fraction of introduced vacancies are uncompensated. As a result, the concentration of vacancies will increase monotonically and the coefficient of radiation diffusion will decrease monotonically with irradiation time. The radiation ordering in cold-deformed samples of Ag + 8.75 at. % Zn was investigated by measuring the electrical resistance, and it was found that the change in electrical resistance was inversely proportional to the square root of the irradiation time on irradiating the cold-deformed silver alloy with 2.315-MeV electrons at an electron flux of 2.8×10^{13} cm^{-2} sec^{-1} at a temperature of 10°C. The process does not depend on the irradiation temperature. (TTT)

42400 LIGHT EFFECTS ON FORMATION OF RECOMBINATION CENTERS IN Si AND Ge INDUCED BY ^{60}Co γ IRRADIATION AT 77 AND 300°K. Konozenko, I. D.; Khivrich, V. I.; Semenyuk, A. K. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 684-7(Apr. 1969). (In Russian).

Data are given on kinetics of formation of recombination centers during γ irradiation of n- and p-type silicon and n-type germanium with various concentrations of alloying impurities and oxygen. The specimens were irradiated by a ^{60}Co γ source with intensity of 1000 r/sec (1.6×10^{12} γ quanta/cm$^2 \cdot$ sec) at 300 and 77°K in darkness and during illumination with a 400-V light source. It was found that formation of recombination centers during irradiation at 77°K were significantly slower than at 300°K. Illumination with white light during irradiation at 77°K increased the rate by a factor of three for oxygen-free n-Si and for oxygen-containing n-Si by a factor of twelve. The rate of formation of recombination centers in n-type germanium at 77°K was 15 times slower than at 300°K. The data confirmed the postulation by J. W. MacKay (Radiation Damage in Solids, STI-PUB/56, Vol. III, Vienna, 1963) on influence of the charge state on separation of metastable Frenkel pairs (vacancies + interstitial atom). (R.V.J.)

42401 EFFECT OF THERMAL-NEUTRON IRRADIATION ON THE ELASTIC MODULI OF LiF. **Gerlich, D.; Holder, J.; Granato, A. V. (Univ. of Illinois, Urbana). Contract No. AT (11-1)-1198. Phys. Rev., 181: 1220-7(May 15, 1969).**

The three elastic-constant changes, and the dilation, of LiF have been measured as a function of neutron flux. The elastic constants all decrease with flux, the change being linear for fluxes less than 10^{16}n/cm^2. This is contrary to expectations based on considerations of Dienes and Nabarro, and consequently, it makes measurements of elastic constants less useful as a tool for distinguishing between interstitials and vacancies than had previously been expected. The ratio of the relative bulk modulus to the volume change is −1.8, which is much smaller than some corresponding values previously reported for copper. A comparison of the experimental results with various available theories shows that a nonlinear elastic sphere-in-hole calculation disagrees the least, the expectations from Zener's considerations come next and the rest of the theoretical estimates differ in order of magnitude and even in sign from the experimental results. (auth)

42402 THE EFFECT OF GAMMA RADIATION ON THE CONDUCTIVITY OF SODIUM CHLORIDE. **Carlson, Michael Claudewell Jon. Ames, Iowa, Iowa State Univ., 1968. 83p. Thesis.**

The electrical resistance of a sodium chloride crystal was measured prior to irradiation and during ^{60}Co γ irradiation at constant temperatures within the extrinsic region. Both the steady-state dc conductivity and blocked conductivity were measured. Dose rates of 2.73×10^3, 5.46×10^3 and 1.09×10^4 rad/min were used. The steady-state conductivity for sodium chloride decreases with increasing absorbed dose until a saturation level lower than the conductivity of the unirradiated material is reached. The saturation level is temperature and dose-rate dependent. The activation energy for the steady-state dc conductivity of sodium chloride during ^{60}Co irradiation at 2.73×10^3 rad/min is higher than for the unirradiated material, but decreases with increasing dose rate. The blocked conductivity of sodium chloride increases during ^{60}Co irradiation. The increase in blocked conductivity is dose-rate dependent, increasing progressively with increasing dose rate. The activation energy for the blocked conductivity decreases progressively with increasing dose rate. The results for the steady-state dc conductivity during irradiation are compatible with mechanisms previously proposed on the basis of conductivity measurements taken after removal of the sample from the irradiation field, if an additional term is added to account for the photo-induced carriers of lower activation energy that are assumed to be produced during irradiation. The results for the blocked conductivity are in agreement with the assumption that the blocked conductivity is due to anion vacancies. The decrease in the activation energy for the blocked conductivity is compatible with the increasing concentration of irradiation-induced anion vacancies found in color-center studies as the irradiation temperature is decreased. (Diss. Abstr.)

42403 ELECTRON PARAMAGNETIC RESONANCE SPECTRA FROM GAMMA-IRRADIATED POTASSIUM THIOCYANATE. **Kewley, Roger (Queen's Univ., Kingston, Ont.). J. Phys. Chem. Solids, 30: 1751-61(July 1969).**

The electron paramagnetic resonance spectra of two distinct radical species were observed following the gamma irradiation of potassium thiocyanate single crystals. The spectrum of the first species appears when a crystal is irradiated at 77°K. For this radical there are two magnetic sites, each characterized by principal g values $g_{||} = 2.004$ and $g_{\perp} = 2.025$ and by principal values of the hyperfine coupling tensor $A_{||} = 8.9$ and $A_{\perp} = 1.4$ Mc/s. For the two sites the radical axis makes angles of 22° and 158° with the (010) axis and in each case the radical axis lies in the (100) plane of the crystal. The five-line hyperfine pattern shows that this radical contains two equivalent ^{14}N nuclei and it is identified as the V-center $(NCS)_2^-$. The spectrum of the second radical is observed in the temperature range 103 to 181°K. This species is also situated at two magnetic sites and has principal g values 2.034, 2.018 and 2.014. It exhibits a three-line hyperfine pattern from one ^{14}N nucleus, the principal values of the hyperfine coupling tensor being 5.6, 6.6, and 6.4 Mc/s. The nature of this second radical is discussed. (auth) (UK)

42404 BORON NITRIDE RADIOLUMINESCENCE. **Flerov, V. I.; Fainer, I. S. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 123-4(1969). (In Russian).**

Temperature dependence for BN radioluminescence in the temperature range of 100 to 500°K at pile radiation excitation was measured. The radioluminescence intensity was found to decrease with diminishing temperature. (auth)

42405 PILE RADIATION EFFECTS ON THE MAGNETIC PROPERTIES OF SOME MANGANESE–ZINC AND NICKEL–ZINC FERRITES. **Kemers, R. Ya.; Ulmanis, U. A. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 15-20(1969). (In Russian).**

Pile radiation effects on the parameters of the hysteresis loop and the magnetization curve of MnZn and NiZn ferrites at 112°C and a fast neutron flux ($E_n > 0.5$ MeV) up to 3.9×10^{18} n/cm^2 are considered. Changes in the form of the hysteresis loop, a decrease in the penetration and the remanent induction, and increase in the coercive force and magnetic field value at which the penetration reaches its maximum value were observed. (auth)

42406 STAGE-III ANNEALING IN MONOCRYSTALLINE GOLD FILMS AFTER 30-keV GOLD–ION IRRADIATION. **Wittmaack, K. (Univ., Munich). Phys. Lett., 29A: 436-7(June 30, 1969).**

Resistivity annealing studies on gold films after gold–ion irradiation at −196°C show that two defect species, presumably interstitials and vacancies, become mobile in stage III, the former above about −70°C and the latter above 0°C. (auth)

42407 PARAMETERS OF SURFACE STATES CAPABLE OF CHARGE EXCHANGE OF THERMALLY OXIDIZED SILICON UNDER THE ACTION OF ^{60}Co γ RADIATION. **Wagemann, H. G.; Braeunig, D. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett., 29A: 456-7(June 30, 1969). (In German).**

Density, energy distribution, and capture cross sections of the surface states on n-type Si are evaluated, before and after ionizing irradiation (^{60}Co). The existence of surface states is intimately related to the nonstoichiometry of SiO_2 near the interface silicon/insulator. (auth)

42408 RECOIL RADIATION DAMAGE FOLLOWING COULOMB EXCITATION. **Jacobs, C. G. Jr.; Hershkowitz, N.; Jefries, J. B. (Univ. of Iowa, Iowa City). Phys. Lett., 29A: 498-9(July 28, 1969).**

Radiation damage was observed in HfC and HfN, which is associated with the recoil of excited nuclei following Coulomb excitation. (auth)

42409 EFFECT OF COMPOUND NUCLEUS ON BLOCKING PHENOMENA FOR ENERGETIC CHARGED PARTICLES. **Komaki, K.; Fujimoto, F. (Tokyo Univ.). Phys. Lett., 29A: 544-5 (July 28, 1969).**

The change of the dip area in the blocking pattern for energetic charged particles due to the formation of compound nuclei is calculated. A numerical example is given for the {111} planar blocking of protons in germanium. (auth)

42410 THERMOLUMINESCENCE OF SODIUM AZIDE. **Kemmey, P. J. (Picatinny Arsenal, Dover, N. J.); Townsend, P. D.; Levy, P. W. J. Phys., C (London), 2: 1125-8(July 1969).**

Thermoluminescence in sodium azide was studied in the temperature range 15 to 300°K by x or gamma irradiation. By analysis of the individual glow peaks at low heating rates it was possible to characterize these peaks from the values of E (activation energy) and S (the pre-exponential factor). (auth) (UK)

42411 THERMOLUMINESCENCE OF POTASSIUM AZIDE. **Townsend, P. D. (Univ. of Sussex, Brighton, Eng.). J. Phys., C (London), 2: 1116-24(July 1969).**

Thermoluminescence measurements on potassium azide (KN_3), using both x-ray or gamma-ray irradiations, indicated that there are many shallow charge trapping levels. In the temperature range from 10 to 525°K a typical sample showed twelve glow peaks and trap depths ranged from 0.045 to 0.6 eV. In contrast, ultraviolet light irradiation produced only the three glow peaks at 46, 70 and 80°K. The glow peaks at 109, 123, 142 and 175°K continued to occur after the sample was repeatedly irradiated and heated, but the peaks at 211, 225 and 245°K disappeared irreversibly after a few irradiation and heating cycles. In addition to the results on "pure" crystals, measurements were made on samples containing various amounts of Ca^{2+}, Ba^{2+}, Sr^{2+} and SO_4^{2-} ion impurity. The data from these doped samples suggested that the 123°K peak is associated with a hole-trapping centre which could be the azide analogue of the V_K centre observed in alkali halides. The thermoluminescence results, coupled with other information, give some information about other defects. (auth) (UK)

42412 STRUCTURAL EFFECTS OF FAST NEUTRONS IN GERMANIUM. **Wittels, M. C. (Washington Univ., St. Louis). J. Appl. Phys., 40: 2909-10(June 1969).**

X-ray diffraction studies and volumetric measurements in nearly perfect crystals of germanium are reported for samples exposed to successive fast-neutron fluences above 10^{20} neutrons/cm^2 at approximately 85°C. Volume expansions greater than 7×10^{-3} were found and complementary lattice parameter results indicated the formation of defect regions having an average density considerably lower than that of the ordered structure. Anomalous fast-neutron dose rate effects were observed by varying this parameter from 2.8×10^{13} neutrons/cm^2/sec to 3.5×10^{14} neutrons/cm^2/sec. (auth)

42413 DEPOSITION OF SILICON BY ELECTRON IRRADIATION OF TETRAMETHYLSILANE. **Faber, E. S.; Tauber, R. N.; Broyde, Barret (Western Electric Co., Inc., Princeton, N. J.). J. Appl. Phys., 40: 2958-64(June 1969).**

The deposition of thin silicon films by the electron beam dissociation of adsorbed tetramethylsilane was investigated. Growth rate was studied as a function of P the vapor pressure of tetramethylsilane, T the substrate temperature, and J the current density. It was found that there is a region where the value of the growth rate can be calculated from the expression $r = KPJ \exp a/T$, where K and a are constants. Assuming a model in which $a = Q/R$ and $K = c\sigma$, where R is the gas constant and c is a calculable constant, Q, the heat of adsorption, was found to be 11.6 kcal/mole and σ, the collision cross section, was determined to have the unexpectedly high value of 3.86×10^3 Å^2 for 300-V electrons. Electron diffraction and transmission electron microscopy showed the as-deposited films to be amorphous. The resistivity of these films varied with thickness and showed a minimum value of approximately 5×10^4 Ω · cm when the film thickness was between 1000 and 1500 Å. Thinner films were less conductive because the high amount of stress in the film increased scattering. Thicker films were less conductive because the impurity content of the films increased with film thickness. Heat treating at 800°C produced extensive grain growth and resistivities dropped by a factor of 10^3. Annealing at 300°C for a few hours decreased the resistivity by about a factor of two although no grain growth occurred at this temperature. (auth)

42414 INTERNAL FRICTION PEAKS IN PURE ALUMINUM OBSERVED BETWEEN 45 AND 72°K AFTER α-PARTICLE IRRADIATION. Riggauer, M. (Technische Hochschule, Munich); Schilling, W.; Voelkl, J.; Wenzl, H. Phys. Status Solidi, 33: 843-50(June 1, 1969).

Relaxation peaks in aluminum found after α-irradiation at 21.4°K are discussed. In the temperature region of 40 to 75°K, four peaks are observed which anneal out in stage II with first order kinetics. Two of them show the natural line-width. From the annealing behavior, the peaks are ascribed to the reorientation of interstitial clusters containing more than two interstitials. The activation energy for reorientation is significantly different from that for annealing. (auth)

42415 DISCRIMINATION OF CHARGED PARTICLES DURING EXO-ELECTRON EMISSION. **Gordan, P.; Scharmann, A.; Seibert, J. (Univ., Giessen, Ger.). Phys. Status Solidi, 33: K97-8 (June 1, 1969).**

The emitted particles are detected in a high vacuum apparatus by an open multiplier with 17 dynodes of Cu–Be alloy. Analyzing of particles is possible by a magnetic field vertical to this acceleration voltage. As the deflection caused by the magnetic field is inversely proportional to the square of the masses of the emitted particles it can easily be distinguished between electron and negatively charged ions. The exo-electron emission of LiF, CaF_2, and $CaSO_4$ was investigated after excitation by high-energy radiation. In case of thermoemission and photostimulated emission the emitted particles are electrons. Without previous excitation, the thermoemission of substances losing water of crystallization at transformations points, e.g., $CuSO_4 \cdot 5\ H_2O$ crystals, consists of negative ions (water ions). (D.H.M.)

42416 ON THE ENHANCEMENT OF COLORATION BY DIVALENT IMPURITIES IN LiF. **Laj, C.; Berge, P. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Status Solidi, 33: K141-2(June 1, 1969).**

In order to study enhancement of γ-ray coloration by divalent impurities in LiF at −70°C, a number of "twin" samples of LiF: Mg^{2+} were annealed in an inert atmosphere at 500°C and quenched into liquid nitrogen. One partner of each couple was reheated to room temperature and then cooled down again quite slowly to −70°C. The second sample was directly reheated from LNT to −70°C. The two were then γ-irradiated together. Results show that the samples that were not reheated to RT colored faster. Assuming a one-to-one correspondence between extrinsic F-centers and preexisting cation-vacancies, the effective quenching temperature was estimated to be about 50°C. (D.H.M.)

42417 CALCULATION OF A MODEL FOR THE FERMI ELECTRON SURFACE IN INDIUM. **Arustamova, M. E.; Mina, R. T.; Pogosyan, V. S. (Inst. of Physics, Erevan). Zh. Eksp. Theor. Fiz., 56: 1983-91(June 1969). (In Russian).**

The electronic computer is employed for setting up a model of the cross section $(1\bar{1}0)$ of the β tube of the Fermi electron surface in indium. The single-parameter pseudopotential model proposed by Harrison is used. For each value of the parameter β the computer yielded such a value of the Fermi energy that the area of the tube cross section equal that measured experimentally on basis of the de Haas–van Alphen effect. Additional experimental data on the size effect were used to determine the pseudopotential and Fermi energy and to set up a model of the electron surface. The anisotropy in the $(1\bar{1}0)$ plane, cross section area of the tube, extremal size and effective mass are calculated for the model and compared with the experiments. The calculated dependence of the model parameters on the quantities measured experimentally permits the estimation of the degree of indeterminacy of the parameters and to select the experimental results which are most important for the model. (auth)

42418 ELECTRON ABSORPTION IN UO_2. **Blank, H. (Institut fuer Transurane, Karlsruhe, Ger.). Phys. Status Solidi, 33: 831-41(June 1, 1969).**

Specimens of UO_2 and U_4O_9 were observed by transmission electron microscopy at electron energies of 100, 500, and 1000 kV. Approximate values of the absorption parameters μ_0 and t_g/τ_g for UO_2 were deduced from bright field pictures of crystal wedges in two beam cases with $s > 0$. The results are compared with data of other substances given in the literature. The stability of the oxygen sublattice in UO_2 and U_4O_9 with respect to 1 MeV electrons is discussed. (auth)

42419 COMMENTS ON "COMPUTER SIMULATION OF SPUTTERING". Robinson, Mark T. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 2670(May 1969).

A rebuttal is given to a paper published previously and abstracted in NSA as 22: 41341. (D.H.M.)

42420 RADIATION ENHANCEMENT OF DIFFUSION FROM EXPERIMENTS OF DIRECTIONAL ORDERING IN Ni–Fe ALLOYS. **Ferro, A.; Soardo, G. P. (Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin). J. Appl. Phys., 40: 3051-3(June 1969).**

Some new evidence is reported on the contribution to the radiation-enhanced diffusion from mechanisms other than the excess vacancy one. The evidence was obtained on a Ni–Fe alloy of the Permalloy type irradiated at about 50°C by comparing the effects of irradiation with the effects of annealing above 50°C after irradiation and of annealing at 400°C of a nonirradiated sample. It was concluded that both the excess vacancy and the thermal-spike mechanisms seem inadequate to explain the radiation-enhanced diffusion during irradiation in Ni–Fe alloys. It is suggested that some interstitial mechanism may give rise to the lattice reordering in the course of irradiation. It is further suggested that the excess vacancy concentration introduced by the irradiation contributes to diffusion only in the course of ordering after irradiation, at temperatures higher than about 120°C. (D.H.M.)

42421 RADIATION-INDUCED INTERSTITIAL CENTERS IN ALKALI METAL HALIDES. **Itoh, N.; Saidoh, M. (Nagoya Univ., Japan). Phys. Status Solidi, 33: 649-56(June 1, 1969).**

Formation of H-, H′-, and V_1-centers in pure KBr and KCl and in Na^+-doped KBr is studied. It is shown that the growth of the H-band is suppressed and the growth of the V_1-band is enhanced by Na^+ impurity, and that the height of the V_1-band is proportional to the height of the H-band. It is shown also that the height of the H′-band is proportional to the square of the height of the H-band below a certain H-center concentration, suggesting that the centers associated with the H′-band are di-H-centers. The kinetics of the formation of these three centers is discussed in terms of the interaction volume of ejected halogen interstitials with H-centers and impurities. (auth)

42422 AN E.S.R. STUDY OF AN X-IRRADIATED SINGLE CRYSTAL OF 5-IODODEOXYURIDINE. **Nice, E. G.; Rorke,**

D. (Univ. of Dundee, Scotland). Int. J. Radiat. Biol., 15: 197-205(1969).

ESR measurement on one of the two radicals associated with x-irradiated single crystals of 5-iododeoxyuridine showed that the radical is formed by the removal of a hydrogen atom from the C_5' carbon atom of the deoxyribose sugar group. The results are explained with a spin Hamiltonian which includes hyperfine splitting tensors for three protons. These hyperfine tensors and the g tensor are evaluated with respect to the crystal axes. The tensors are shown to have their principal axes lying approximately along directions predicted from a model based on the molecular structure obtained from x-ray analysis. (auth)

42423 E.S.R. STUDY OF X-IRRADIATED SINGLE CRYSTALS OF 5-BROMODEOXYURIDINE AND 5-IODODEOXYURIDINE. Nice, E. G.; Rorke, D. (Univ. of Dundee, Scotland). Int. J. Radiat. Biol., 15: 207-13(1969).

ESR measurements at 9.27 and 37.10 GHz on one of the two radials associated with x-irradiated single crystals of 5-iododeoxyuridine and 5-bromodeoxyuridine (triclinic) show that the radical is formed by the addition of a hydrogen atom to the C_4 carbon atom of the pyrimidine base. The observed hyperfine splitting has been studied in detail, and the principal values of the g tensor (2.052, 2.037, 1.992 for I.D.U. and 2.023, 2.023, 2.003, for B.D.U.) are among the highest recorded values for organic free radicals. The principal axes of the g tensor were found to be approximately along directions predicted from a model based on the molecular structure obtained from x-ray crystallographic analysis. Unusual behavior of the bromine and iodine hyperfine lines has been observed, and a mechanism is suggested which accounts for the production of the two different free radical species in both materials. (auth)

42424 CURRENT OSCILLATION AND SOME PHOTOELECTRIC PROPERTIES IN HIGH RESISTIVITY GALLIUM ARSENIDE PRODUCED BY IRRADIATION OF FAST NEUTRONS. Shirafuji, Junji (Hitachi Ltd., Tokyo). Jap. J. Appl. Phys., 8: 898-909 (July 1969).

Current oscillation and some photoelectric properties in high resistivity n-type GaAs produced by fast-neutron irradiation were investigated. The spectral response in the photocurrent has a broad peak near the band edge and a relatively high photosensitivity still remains at wavelengths longer than the band edge. The photocurrent shows a drastic thermal quenching which begins at about 350°K. In as-irradiated and annealed samples current oscillations caused by the traveling high-field domain are observed. It is concluded that the current oscillation is due to the field-dependent trapping effect. The current oscillation at room temperature launches even in the dark, while at low temperatures it occurs only under illumination of light. The lower limit of $n \cdot l$ product necessary for leading to the oscillation is estimated as 5×10^8 cm^{-2}. The oscillation characteristics, especially at low temperatures, are well understood by a simple model. (auth)

42425 CYLINDRICAL DAMAGE SHELLS IN IRRADIATED VANADIUM. Rau, Robert C.; Ladd, Robert L. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Appl. Phys., 40: 2899-2904(June 1969).

Transmission-electron-microscopy studies of neutron-irradiated vanadium single crystals revealed the presence of cylindrical regions of high damage concentration surrounding elongated fibrous precipitates. These precipitates were identified as tetragonal V_3B_2 and are oriented along ⟨100⟩ directions in the cubic vanadium lattice. The cylindrical damage shells are duplex in nature, consisting of a highly damaged inner region of about 1.3-μ radius and a less highly damaged outer region of about 2.6-μ radius. These two damage shells consist of small defect clusters produced by recoiling lithium ions and alpha particles, respectively, generated by $^{10}B(n,\alpha)^7Li$ transmutation reactions. Post-irradiation annealing at temperatures up to 1400°C eliminates the defect clusters and produces dislocation tangles and blocky precipitates in the inner shell and spherical cavities or bubbles in the outer shell. The precipitates in the inner shell are believed to be LiV_2O_5, while the bubbles in the outer shell are evidently formed by the agglomeration of helium atoms. Although spherical damage shells surrounding boron-containing particles have been observed in several other irradiated metals and alloys, this represents the first known observation of nonspherical shells. (auth)

42426 ION IMPLANTATION: A NEW METHOD OF DOPING SEMICONDUCTORS. I. Large, L. N. (Services Electronics Research Lab., Baldock, Eng.). Contemp. Phys., 10: 277-98 (May 1969).

A new method for doping semiconductors consists of ion implantation, where impurities are injected in the form of high-energy ions. The range of these ions is well defined and is a function of ion energy and mass, the nature of the crystal and its orientation to the beam. The current theory for the range of heavy ions in amorphous and crystalline materials is summarized with the aid of a simple model that demonstrates some of the important features. Some experimental results for the ranges of particles in semiconductors are given and the various methods used to obtain them are reviewed. In addition, typical apparatus used for ion implantation is described with particular reference to ion sources. (auth) (UK)

42427 RARE GAS DIFFUSION IN NaCl. Matzke, Hj. (CCR-EURATOM, Ispra, Italy); Rickers, G.; Soerensen, G. Z. Naturforsch., 24a: 820-6(May 1969).

The mobility (diffusion and trapping) of the heavy rare gases Kr, Xe, and Rn in pure and doped NaCl single crystals was measured following ion bombardment to various integrated doses (10^8 to 2×10^{16} ions/cm^2) and at energies between 30 and 500 keV. No obvious effect of doping on release was found. At low gas concentrations, release was compatible with volume diffusion yielding an activation enthalpy, ΔH, of 1.5 ± 0.2 eV. This value was obtained for both very low and very high bombardment energies (≈1 and 500 keV) thus indicating that the same release mechanism is operative near the surface and in the bulk material. For this release mechanism, a mobility in small vacancy clusters was suggested. At higher gas concentrations, the release was shifted towards higher temperatures. This retarded release was explained by transient trapping, i.e., by gas–gas or gas–damage interactions, and was shown to have a partially single jump character. Again, the result was the same for low and high bombardment energies. (auth)

42428 FISSION DAMAGE IN CRYSTALS. Chadderton, L. T.; Torrens, I. McC. London, Methuen and Company, 1969. 265p. 85s.

The subject is discussed under the following headings: nuclear fission; passage of fission fragments through crystalline matter; experimental methods of irradiation; direct observation of bombarded lattice; indirect observation of bombarded lattice; imaging of fission fragment tracks by electron diffraction contrast; nature of damage in metals; heat-sensitive crystals; nature of damage in lead iodide; atomic displacement in lead iodide lattice, atomic displacement in alkali halides; creation of defects by electron excitation; spikes of electronic excitation; and creation of defects by atomic displacement. (UK)

42429 SUPRALINEAR CURRENT-VOLTAGE-DEPENDENCE IN IRRADIATED FUSED SILICA. Onnasch, Dietrich (Univ., Kiel). Z. Naturforsch., 24a: 851-2(May 1969).

The measured field- and temperature-dependence of γ-ray-induced current in synthetic fused silica is explained by a field-dependent electron capture cross section. The comparison with a model gives a constant mobility within the region of 8 to 300°K. With high electric fields the acousto–electric effect is observed. (auth)

42430 SPUTTERING YIELD MEASUREMENTS WITH LOW-ENERGY METAL ION BEAMS. Hayward, W. H.; Wolter, A. R. (Boeing Co., Seattle). J. Appl. Phys., 40: 2911-16(June 1969).

Sputtering yields of metal ion beams on polycrystalline films for energies below 1 keV were measured in situ using crystal microbalance techniques. Self-sputtering yields were determined for Au, Cu, Ag, Cr, and Al for energies from 10 to 500 eV. These yields were consistent with some previous noble-gas sputtering yields when only the difference in ionic mass was taken into account. Residual oxygen significantly lowered the self-sputtering yields of Al and Cr for all energies from 0 to 1 keV and the collection rate of oxygen was apparently greater for ions of about 10 eV. Sputtering yields of films by dissimilar metal ions were most strongly influenced by the type of metal in the beam, rather than by the target material, even for high ion energies. (auth)

42431 THERMAL RELEASE OF INERT GASES FROM (110) AND (211) TUNGSTEN SURFACES. Kornelsen, E. V.; Sinha, M. K. (National Research Council, Ottawa). J. Appl. Phys., 40: 2888-94(June 1969).

Clean (211) and (110) surfaces of tungsten were bombarded with inert-gas-ion beams in the energy range 40 eV to 5 keV. Thermal desorption spectra of the trapped gas show patterns of peaks characteristic of the ion and the face bombarded. The results are comparable to those obtained previously for a (100) tungsten surface. In particular, all peaks below 1650°K are associated with desorption from sites within about 10 Å of the crystal surfaces, while the single peak above 1700°K is the result of isotropic diffusion of ions which have penetrated more than 10 Å. Evidence is presented to support the hypothesis that the trapping sites consist of substitutional gas atoms and associated point defects. (auth)

42432 THERMOLUMINESCENCE AND THERMALLY STIMULATED CONDUCTIVITY OF LiF. Boehm, M.; Scharmann, A. (Univ., Geissen, Ger.). Z. Phys., 225: 44-59(1969). (In German).

Pure and doped LiF-crystals were investigated with respect to thermoluminescence and thermally stimulated conductivity after excitation with x rays. The peak near 107°K can be correlated with the decay of H centers and is described by a special model. On the basis of the analysis of the glow curves, a temperature-dependent mobility of the electrons is assumed. The decay of the V_k centers is responsible for two other glow peaks near 128 and 138°K peak, the experimental results are explained by a general kinetic consideration which requires again a temperature dependence of the carrier mobility. (auth)

42433 THE CHARACTERIZATION OF FAST-NEUTRON RADIATION-INDUCED TRAPS IN SILICON BY THE USE OF SPACE-CHARGE-LIMITED CARRIER INJECTION. Henderson, Homan Thurman. Dallas, Southern Methodist Univ., 1968. 217p.

Thesis.

A dramatic trap-filled-limit characteristic was observed in neutron-irradiated silicon at 77°K, preceded by a distinct Ohm's law region. The experimental results form two bounding sides of Lampert's "triangle" in a logarithmic volt–ampere plot, wherein all conduction possibilities in solids are theoretically confined (at constant mobility). Independent methods of determining the extrapolated intersection of Child's trap-free square law with the Ohm's law region and the TFL voltage, fit the experimental pattern very well. The oxygen-vacancy A-center complex, lying at E_c-0.17 eV, was identified as the trap responsible for the TFL behavior at 77°K. The TFL behavior is characterized by an essentially vertical line, ranging over a region in excess of three orders of magnitude in current at constant voltage, before deviating toward the trap-free square law. Lower-level (modified) versions of Child's law were also observed, and other TFL behavior was found possible even at room temperature. Phenomenological observations of negative differential resistance have been noted, which are apparently due to double injection. It was found that appropriate room temperature contacting and surface-state band bending can be achieved in high-resistivity, irradiated silicon, which will function well to liquid nitrogen temperatures. The results of this research suggest that space-charge-limited carrier injection can be a powerful tool in the definition of radiation defects in semiconductors. (Disser. Abstr.)

42434 DECAY OF ELECTRON CENTERS IN ^{60}Co γ-IRRADIATED POLYCRYSTALLINE NaCl ON ADSORPTION OF GASES. Rabe, J. G.; Joppien, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Z. Naturforsch., 24a: 796-802(May 1969). (In German).

Ionizing radiation generates color centers in sodium chloride. On adsorption of gases on preirradiated salt the concentration of electron centers decreases. Adsorbed azoethane partly decomposes forming nitrogen. About one to five electron centers disappear per nitrogen molecule formed depending on experimental conditions (temperature, amount of azoethane adsorbed and pretreatment of the salt). Electron centers disappear and nitrogen is formed with identical rates following first-order kinetics. It is suggested that adsorbed molecules interacting with the surface cause electrons or holes to escape from their traps and eventually to recombine. (auth)

42435 SUBSTITUTIONAL DOPING DURING LOW-DOSE IMPLANTATION OF Bi AND Tl IONS IN Si AT 25°C. Eriksson, L.; Bellavance, G. R.; Davies, J. A. (Chalk River Nuclear Labs., Ont.). Radiat. Eff., 1: 71-3(Jan. 1969).

High substitutional components were observed in Bi and Tl implants in silicon without any annealing treatment. Implant conditions were ~10^{13} ions/cm^2 at 40 keV and 25°C. The lattice location of the implanted atoms was determined by means of the "channeling" technique. (auth)

42436 SPECIFIC VOLUME DEPENDENCE OF THE ACTIVATION ENERGY FOR ANNEALING IN NEUTRON-DAMAGED SILICA GLASS. Lungu, S. (Inst. for Atomic Physics, Bucharest). Radiat. Eff., 1: 69-70(Jan. 1969).

A theoretical interpretation is presented of the specific volume dependence of the activation energy for annealing in neutron-damaged silica glass. Graphic data are given for the dependence of the activation energy on the defect concentration (expressed as a ratio to the saturation level. (D.H.M.)

42437 CHANNELING OF FISSION FRAGMENTS. Mory, J.; Delsarte, G. (CEN, Fontenay-aux-Roses, France). Radiat. Eff., 1: 1-4(Jan. 1969). (In French).

The channeling of fission fragments in metals is studied, in particular in platinum and tungsten. It is shown that this channeling is very important, and that the conditions of channeling for fission fragments are more rigorous than for lighter particles, such as α particles. The good resolution of images obtained by "channelography" suggests that this technique will be very useful in the study of crystalline defects in metals. (auth)

42438 INFLUENCE OF NEUTRON IRRADIATION ON THE ELECTRICAL PROPERTIES OF NON-STOICHIOMETRIC Cr_2O_3. Cojocaru, L. N. (Inst. for Atomic Physics, Bucharest). Radiat. Eff., 1: 11-13(Jan. 1969).

Effects of fast neutrons on the electrical conductivity and thermoelectric power of Cr_2O_{3+x} were studied. It is shown that both the conductivity and thermoelectric power are reduced after an irradiation of about 10^{17} nvt. This observation is explained in terms of a hole concentration and mobility reduction and by an electron concentration increase. The effect depends on an oxygen excess. (auth)

42439 A NOTE ON INTEGRAL EQUATIONS OF THE KINCHIN–PEASE TYPE. Sigmund, P. (Argonne National Lab., Ill.). Radiat. Eff., 1: 15-18(Jan. 1969).

It is shown that the solution of the integral equation governing production of Frenkel pairs in random collision cascades is essentially linear at large energies within the elastic collision region, for a rather general class of scattering cross sections. A standard value for the proportionality constant is suggested, and some implications are discussed. (auth)

42440 THE STAGE-III RECOVERY IN ELECTRON-IRRADIATED ALUMINUM. Bauer, W. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Radiat. Eff., 1: 23-31 (Jan. 1969).

The irradiation-produced resistivity recovery of 99.9999% pure annealed and prequenched aluminum foils was studied. The prequenched specimen exhibited two distinct recovery peaks, at 245°K and 320°K (Stage IV), whereas the unquenched specimen exhibited only one peak at 255°K (Stage III). The average activation energy of the Stage-III recovery. The implications of these results on existing recovery methods are discussed. (auth)

42441 A REFINED OXIDATION-STRIPPING TECHNIQUE OF THIN N-TYPE Si FILMS. Przyborski, W. (Research Establishment Risoe, Roskilde, Demark); Roed, J.; Lippert, J.; Sarholt-Kristensen, L. Radiat. Eff., 1: 33-9(Jan. 1969).

When energetic ions are implanted in Si crystals, an anodization-peeling technique can be used as a precise tool for the determination of the ion concentration profiles, when proper precautions are taken. Anodic oxidation rates of n-type silicon in ethylene glycol solution were studied, using neutron-activation analysis and it was found that three factors (chemical pretreatment, illumination, and temperature) seem to have the greatest influence on the anodization process and the reproducibility. Furthermore, by using a chemical posttreatment, involving evaporation of the liquid before the activity is measured, an error of less than ±2% for an anodic voltage of 180 V was obtained. In addition, some data on oxidation in water and on etching of Si in hydrofluoric acid are presented. (auth)

42442 INFRARED STUDIES OF OXYGEN- AND CARBON-ASSOCIATED DEFECTS IN ELECTRON-IRRADIATED SILICON. Stein, H. J.; Vook, F. L. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff., 1: 41-6(Jan. 1969).

Infrared absorption measurements were made before and after 90°K electron irradiations of silicon samples which contained either dispersed oxygen, carbon, or carbon plus oxygen. Irradiation-produced absorption bands associated with two distinctly different defects are observed depending on the oxygen and carbon content of the silicon. One center is the well-known vacancy-oxygen A-center defect (836-cm^{-1} band) and is formed on irradiation in oxygen-containing silicon with a magnitude which is independent of the carbon content. Measurements have correlated the formation of one A-center with the loss of one interstitial oxygen atom, thereby indicating that A-center formation occurs by vacancy trapping at interstitial oxygen atoms. A second center (922- and 932-cm^{-1} bands) is formed only in silicon crystals which contain both oxygen and carbon. The results indicate that this center is formed by the trapping of a silicon interstitial at a carbon–oxygen complex. (auth)

42443 STAGE-III RECOVERY IN ELECTRON-IRRADIATED PLATINUM. Duesing, G.; Schilling, W. (Kernforschungsanlage, Juelich, Ger.). Radiat. Eff., 1: 65-7(Jan. 1969).

The dominant high-temperature recovery peak in irradiated platinum is observed between 500 and 700°K, dependent on dose.

Prequenched irradiation platinum shows an additional peak at higher temperatures. Stage III in platinum is relabeled Stage II. (auth)

42444 BOMBARDMENT OF ZINC SULPHIDE SINGLE CRYSTALS WITH 30-keV ELECTRONS: LIGHT EMISSION. Williams, P. M.; Yoffe, A. D. (Cavendish Lab., Cambridge, Eng.). Radiat. Eff., 1: 61-4(Jan. 1969).

Cathodoluminescence in hexagonal zinc sulfide single crystals was investigated by irradiation of specimens at 100°K with 30-keV electrons in a scanning electron microscope. The effects on the luminescence of stacking faults were observed by simultaneously recording both the luminescence micrograph and the emission spectrum, and by subsequent examination of the same single crystals in a transmission electron microscope. With thicker crystals, opaque to the latter, an intense emission was observed from thin basal-plane intergrowths, which was strongly dependent on the electron current density. (auth)

42445 EFFECT OF NEUTRON BOMBARDMENT ON MICA. Patel, A. R.; Raju, K. S. (Sardar Patel Univ., Vallabh Vidyanagar, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 492-5(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

The nature of defects introduced in mica by neutron bombardment was investigated. Transparent crystals turned translucent on radiation. Irradiated cleavages had a high density of pits with different degrees of clustering, whereas its unirradiated counterpart had very few pits. Heating reduced the number and size of the pits on the irradiated cleavages. (M.C.G.)

42446 RADIATION DAMAGE IN BARITE. Patel, A. R.; Koshy, Jacob (Sardar Patel Univ., Vallabh Vidyanagar, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 488-91(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

The nature of the defect introduced in barite crystals by neutron bombardment was investigated. After irradiation the transparent crystals became colored. The color changed from light yellow for small doses to a very deep yellow for higher doses. The yellow color disappeared on heating the crystal at 500°C for 48 hr. The hardness of the barite crystals increased on neutron irradiation. The density of pits on irradiated cleavages was much larger than that of nonirradiated ones. (M.C.G.)

42447 ATTEMPTS AT IDENTIFICATION OF NEW BANDS OBSERVED IN X-IRRADIATED KCl SINGLE CRYSTALS. Tomar, M. S.; Sen, S. C. (Indian Inst. of Tech., Kanpur, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 415-18(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

The effects of x rays on the surface of KCl crystals and on aggregate centers were studied. A strong F-band along with M, R, and N bands were obtained. (M.C.G.)

42448 PARTICLE SCATTERING AND PENETRATION THROUGH PERFECT CRYSTALS. Pathak, A. P.; Yussouff, M. (Indian Inst. of Tech., Kanpur, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 370-4(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

An approximation using the T-matrix approach is given for resonance scattering and anomalous transmission. The resonance condition was obtained and the implications of the formalism regarding anomalous penetration described. (M.C.G.)

42449 EFFECT OF CRYSTAL GROWTH TEMPERATURE ON THE ESR SPECTRA OF IRRADIATED Na_2SO_4 AND $Li_2SO_4H_2O$. Hariharan, N.; Sobhanadri, J. (Indian Inst. of Tech., Madras). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 291-4(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

Instead of radioinduced coloration of Na_2SO_4 and $Li_2SO_4 \cdot H_2O$ at different temperatures, the crystals were grown at different temperatures and then exposed to radiation at a constant temperature. On exposure to x radiation, Na_2SO_4 crystals grown at 35°C turned blue while the crystals grown at 65°C showed a purple coloration. Single crystals of $Li_2SO_4 \cdot H_2O$ grown at 35 and 60°C were exposed to uv and x radiation. Though no visible coloration could be detected after irradiation, the ESR spectra were markedly different. (M.C.G.)

42450 MODEL FOR NEUTRON SCATTERING FROM SHORT-RANGE ORDERED PARAMAGNETS. Rao, L. Madhav; Dasannacharya, B. A.; Murthy, N. S. Satya; Iyengar, P. K. (Bhabha Atomic Research Centre, Trombay, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 148-51(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

A magnetic analog of the modified de Gennes approximation (MDA) applied to an isotropic exchange coupled paramagnet showing short range order in spin structure is presented. The equation for the differential scattering cross-section for neutrons scattered from such a paramagnet is given. Magnetic scattering of cold neutrons from paramagnetic MnO was calculated at a temperature near Neêl point at 124°K and at room temperature. (M.C.G.)

42451 PREPARATION AND PROPERTIES OF ELECTRONIC MATERIALS: OPTICAL AND NUCLEAR RADIATION, HELD IN CHICAGO, AUGUST 11-14, 1968. Trans. Met. Soc. AIME, 245: 441-599(Mar. 1969). (CONF-680838).

Separate abstracts were prepared for 7 of the 24 papers presented. The remaining 17 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 41187, and 42452–42457.

42452 ION IMPLANTATION DOPING OF SILICON FOR SHALLOW JUNCTIONS. Fairfield, John M. (IBM Components Div., Hopewell Junction, N. Y.); Crowder, Billy L. Trans. Met. Soc. AIME, 245: 469-73(Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

The implantation of B^+, P^+, and As^+ into silicon was studied with the purpose of making shallow p–n junctions. The influence of such parameters as ion energy, target orientation and temperature, total dose, and annealing schedule was investigated. An energy range of 70 to 300 keV was used for boron and phosphorus implants and up to 500 keV for arsenic. It is found that the experimental projected range agrees well with theory and that shallow junction depths can be made reproducibly. (auth)

42453 ANNEALING OF HIGH-ENERGY ION IMPLANTATION DAMAGE IN SINGLE CRYSTAL SILICON. Schwuttke, G. H. (IBM East Fishkill Lab., Hopewell Junction, N. Y.); Brack, K. Contract AF19(628)-68-C-0196. Trans. Met. Soc. AIME, 245: 475-81(Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

Annealing properties of subsurface amorphous layers produced through high-energy ion implantation in silicon are studied. The buried layers are produced through the implantation of ions (nitrogen), ranging in energy from 1.5 to 2 MeV. X-ray interference patterns, transmission electron microscopy, and resistivity profiling are used to study the annealing characteristics of the ion damage. The annealing experiments indicate a low temperature (below 700°C) and a high temperature (above 700°C) region. Significant changes occur in the amorphous layer during the high-temperature anneal. Such changes are correlated with the recrystallization of the amorphous silicon and the formation of subsurface (buried) silicon–nitride films. (auth)

42454 ION IMPLANTATION IN DIAMONDS. Carlson, Richard O. (General Electric Co., Schenectady, N. Y.). Trans. Met. Soc. AIME, 245: 483-90(Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

Ions of ^{31}P and ^{11}B were implanted in natural insulating diamond macles. The thin (~0.4 μ) layers showed sheet resistances of 10^7 to 10^{11} ohm per sq and activation energies of 0.17 to 0.34 eV above room temperature. However, no Hall effect could be measured, indicating that mobilities were less than 1 to 10 sq cm per (v-sec). Such low mobilities may be due to excessive scattering due to radiation damage in the bombarded layer or to very high concentrations of active compensating impurities. Annealing did not materially change the room-temperature properties, but the temperature was limited to ~800°C by surface graphitization, the latter process probably being accelerated by lattice damage in our diamonds arising from the ion bombardment. A weak n-type thermoelectric power was detected after ^{31}P irradiation, but it cannot be presumed that the phosphorus ions were made active as donors in diamond. The natural diamonds have a high and uncontrolled concentration of impurities and, when coupled with the radiation damage and graphitization problems, would appear to seriously limit the quality of semiconductor that we can presently achieve by ion implantation in diamond. (auth)

42455 SOME PROPERTIES OF ION IMPLANTED BORON IN SILICON. Seidel, T. E.; MacRae, A. U. (Bell Telephone Labs., Murray Hill, N. J.). Trans. Met. Soc. AIME, 245: 491-8(Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

The dependence of the electrical and crystalline properties of silicon containing ion implanted boron atoms was studied as a function of the incident dose, substrate temperature, and annealing temperature. Hall effect studies show that the compensation due to defects is negligible after annealing at and above 500°C for a dose of 10^{13} ions per sq cm. Steps occur in the isochronal annealing curve for the sheet resistance at 300 and 800°C and the mechanisms responsible for these steps are discussed. The range of the ions at 150 keV is 3500 ± 500 Å. Electron diffraction studies on samples implanted with 150 keV ions show the existence of damaged (polycrystalline) silicon closer to the surface than the range of the ions. Etching and subsequent annealing of etched and unetched specimens suggest that the polycrystalline silicon is closer to the surface than the bulk of the distribution of ions. (auth)

42456 DIFFUSION OF IMPURITIES IN IRRADIATED SILICON. Oldham, W. G. (Univ. of California, Berkeley). Trans. Met. Soc. AIME, 245: 505-9(Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

By monitoring the capacitance of abrupt p–n junctions it is possible to follow the motion of substitutional impurities. A p–n junction is formed by growth of silicon from an Al–Si alloy on an n-type silicon substrate at a temperature in the range 650 to 750°C. The diodes are etched and sorted for consistent V–I and capacitance behavior and separated into groups. After irradiation, each set with an unirradiated control set is annealed to various temperatures for 10 min and the capacitance remeasured. For very heavily doped diodes (~10^{19} per cm^{-3}) observable capacitance changes occur at neutron fluences of >10^{15} per cm^3. The results may be interpreted in several ways, the simplest of which is to assume simple vacancy diffusion with small impurity–vacancy interaction (at the diffusion, i.e., annealing temperature of 700°C). In this interpretation it is found that a typical vacancy makes about 10^{24} jumps and travels about 10^{-5} cm before disappearing. The required effective annihilation center density is about 10^{16} per cm^3. Estimates of the vacancy–impurity interaction can be made and the above numbers corrected, but for any reasonable assumptions the number of vacancy sinks cannot be much reduced. (auth)

42457 NEUTRON-INDUCED CARRIER-REMOVAL EFFECTS IN SILICON. Buehler, Martin G.; Kendall, Don L. (Texas Instruments, Inc., Dallas). Trans. Met. Soc. AIME, 245: 511-15 (Mar. 1969).

From Conference on Preparation and Properties of Electronic Materials: Optical and Nuclear Radiation, Chicago, Ill. See CONF-680838.

A simple physical model was developed to fit carrier-removal data in silicon irradiated near room temperature with reactor spectrum neutrons. Commonly observed donor and acceptor defect energy levels are assumed to be introduced linearly with neutron fluence. The donor levels (in ev) are $E_v + 0.16$, $E_v + 0.27$, and $E_v + 0.31$ and the acceptor levels are $E_c - 0.55$, $E_c - 0.40$, and $E_c - 0.17$, where E_v and E_c are the valence and conduction band energies, respectively. The introduction rates of each level are adjusted to fit literature initial carrier-removal rate data. When normalized with respect to the $E_v + 0.27$ level, the relative values of introduction rates are 5.3, 1.0, 3.1, 1.0, 2.0, and 20.0, respectively for the six levels indicated above. To fit $p-\varphi$ (hole concentration vs neutron fluence) and $n-\varphi$ (electron concentration vs neutron fluence) data, the introduction rates are multiplied by a factor which preserves the relative values given above. This factor depends upon irradiation temperature, reactor energy spectrum, neutron fluence calibration, and oxygen content of silicon. (auth)

42458 ELECTRON AND NEUTRON IRRADIATION OF BORON AND PHOSPHORUS-DOPED SILICON AT 80°K. Clark, C. D.; Fernandez, A.; Thompson, D. A. (Univ. of Reading, Eng.). Phil. Mag., 20: 301-10(Aug. 1969).

Conductivity and Hall effect measurements were made on boron- and phosphorus-doped silicon which had been irradiated at 80°K either in a nuclear reactor or with 2 MeV electrons. For the boron-doped samples, a significant carrier removal rate attributed to the $^{10}B(n,\alpha)^7Li$ reaction was observed. The carrier removal rates in electron-irradiated B- and P-doped samples were much smaller than predicted by a calculation based upon one carrier removed for each displacement produced. On the other hand, the fast and thermal neutron carrier removal rates were consistent with such a hypothesis, and it is suggested that the defects introduced by neutron irradiation are small complexes with associated levels deep in the forbidden gap. It is suggested that electron irradiation produces primarily neutral vacancies with levels so close to the valence band that they have no effect on the carrier removal rates in either B- or P-doped silicon. (auth) (UK)

42459 SELF-TRAPPED HOLE AND THE SELF-TRAPPED EXCITON IN ALKALINE EARTH FLUORIDES. Hayes, W.; Kirk, D. L.; Summers, G. P. (Clarendon Lab., Oxford). Solid State Commun., 7: 1061-4(Aug. 1969).

The thermally induced decay of optically aligned V_k centers was monitored by EPR methods in CaF_2 and only linear (0^0) motion of the V_k center was observed. The linear motion was found only in the lower temperature stages of decay in SrF_2; random motion sets in at higher temperatures. Only random motion of V_k centers occurs in BaF_2. An emission band of the self-trapped exciton was observed in x-ray fluorescence and was identified by comparison with a recombination luminescence band of the V_k center. (auth) (UK)

42460 TRAPPING OF ELECTRONS IN IRRADIATED ICE. Weiss, Joseph J. (Univ. of Newcastle upon Tyne, Eng.). Phil. Mag., 20: 259-66(Aug. 1969).

It is known that the formation of colour centres in irradiated ice is due to trapped electrons. The hypothesis is put forward that the electrons are trapped in vacancies created by the radioinduced decomposition of water molecules in the hydrogen-bonded ice structure and displacement of the molecular fragments by (focused) collisions in the lattice. If an electron occupies such a vacancy, rotation of (two) adjacent water molecules or diffusion of Bjerrum defects induced by the field of the electron should give an efficient trap. It can also be shown that the formation of such a cavity for trapping the electron appears to be essential on energetic grounds. It is suggested that basically a similar trapping mechanism is operative in other hydrogen bonded solids and liquids. (auth) (UK)

42461 EFFECTS OF NEUTRON IRRADIATION IN p-TYPE SILICON. Nakashima, Kenshiro; Inuishi, Yoshio (Osaka Univ.). J. Phys. Soc. Jap., 27: 397-405(Aug. 1969).

Radiation damages in silicon single crystals irradiated by pile neutrons were investigated using Hall effect and the carrier lifetime measurements. In p-type silicon donor-like centers were found to be introduced, the energy level of which located at about $E_V + 0.3$ eV. Its introduction rate did not depend on the kind of impurities, carrier concentrations and crystal growth methods. At the small irradiation dose level the minority carrier lifetime was controlled by the recombination through the defect centers. With the increase of dose the trapping effect became remarkable even at room temperature in conjunction with the recombination effect. At 2.6×10^{12} nvt irradiation dose the trapping level at $E_C - 0.16$ eV was found to be predominantly introduced. The annealing studies of 2.6×10^{12} nvt irradiated p-type silicon indicated that trap centers annealed at around 200°C, subsequently recombination centers annealed at 430 ~ 480°C. Recombination centers annealed over the broad temperature range and did not show any sensitivity to the existence of oxygen impurities. The results were tentatively interpreted on the basis of the model proposed by Gossick. (auth)

42462 OBSERVATION OF THE PARAMAGNETIC RESONANCE LINES ($\Delta_s = 1$, $\Delta M_1 = \pm 1$ OR ± 2) OF ClO_2 IN $KClO_3$ IRRADIATED AT LOW TEMPERATURE. Fayet, Jean-Claude; Pariset, Christian; Thieblemont, Bernard (CNRS, Orsay, France). Compt. Rend., Ser. B, 268: 1317-20(May 19, 1969). (In French).

The study by EPR and optical absorption of a $KClO_3$ single crystal irradiated by x rays at 77°K shows the molecule ClO_2. In particular, the quadrupole coupling, known for the free molecule, permits the position of the EPR lines ($\Delta M_s = 1$, $\Delta M_1 = 1$ or $\Delta M = \pm 2$) to be accounted for. (tr-auth)

42463 IONISATION, CONDUCTIVITY, AND BREAKDOWN IN DIELECTRIC LIQUIDS. Adamczewski, I. London, Taylor and Francis, 1969. 454p. 170s.

Translation from Polish text.

The subject is discussed under the following main headings: General physicochemical properties of dielectric liquids; action of ionising radiation on matter (principal effects of ionising radiation; stopping of ionising particles by matter; absorption of X- and γ-rays; principles of ionising radiation dosimetry; mechanism of interaction of ionising radiation in liquids); electrical conduction in dielectric liquids at low fields; electrical conductivity of dielectric liquids at high fields and electrical breakdown. (UK)

42464 A STUDY OF ZERO-PHONON LINES IN ELECTRON-IRRADIATED, NEUTRON-IRRADIATED AND ADDITIVELY COLOURED MgO. Chen, Y.; Sibley, W. A. (Oak Ridge National Lab., Tenn.). Phil. Mag., 20: 217-24(Aug. 1969).

A study was made of zero-phonon lines produced by ionizing irradiation and heat treatment in irradiated and additively coloured MgO crystals. It appears that the zero-phonon lines at 361.5 and 1044.5 nm observed in neutron-irradiated crystals are due to different absorption transitions of the same defect. Numerous new zero-phonon lines were observed when neutron-irradiated crystals were annealed above 500°C and given short ionizing irradiations. Of those the lines at 1081.6 and 1324.2 nm can also be produced in electron-irradiated, additively coloured, and deformed crystals. It is suggested that these two lines are due to F-aggregate centres (aggregate of negative-ion vacancies). (auth) (UK)

42465 INTERACTIONS OF POINT DEFECTS WITH IMPURITIES IN SILICON. Hirata, Masako; Hirata, Mitsuji; Saito, Haruo (Osaka Univ.). J. Phys. Soc. Jap., 27: 405-14(Aug. 1969).

The minority carrier lifetime in gamma-irradiated silicon crystals was studied. In floating-zone n-type crystals containing phosphorus, arsenic, antimony, or bismuth, there are two annealing stages in the temperature range 100−280°C and in both stages there is a strong dependence of activation energies E_a and frequency factors on the atomic size of the impurity. The relationship between E_a and covalent radii of the impurity atom can be experimentally expressed in linear functions. The defect which anneals in the lower temperature stage is a complex of donor atoms associated with a vacancy type defect. Si−E center anneals in the higher temperature stage and the values of activation energies completely agree with those obtained by Watkins et al. in their experiments of reorientation of donor-vacancy axis. The defects of both stages are considered to migrate to the sinks of oxygen after jumps of about 10^5. This study shows only one example of an impurity atom which moves with a vacancy in silicon without breaking up. (auth)

42466 ESR OF NEUTRON-IRRADIATED BaF_2 CRYSTALS. Kazumata, Y. (Japan Atomic Energy Research Inst., Tokai). Phys. Status Solidi, 34: 377-84(July 1, 1969).

Neutron-irradiated BaF_2 was studied by ESR. The thermal stability of the F centers formed by neutron irradiation was investigated. Three types of V centers (V_K, V_F, and V_{111}) were also observed. The spin Hamiltonian parameters of the three V centers were calculated from experimental data, and the thermal stability of the centers were studied by a pulse-annealing method. A model of the new type of V center (F_2^- molecule-ion in the [111] direction) is proposed. (auth)

42467 THE KOHLER RULE OF MAGNETORESISTANCE IN NEUTRON-IRRADIATED ALUMINUM AT 4.6°K. Boening, K.; Fenzl, H. J.; Olympios, E.; Welter, J. M.; Wenzl, H. (Technische Hochschule, Munich). Phys. Status Solidi, 34: 395-401 (July 1, 1969).

An investigation is made of the range of validity of the Kohler rule for the transverse magnetoresistance of aluminum at 4.6°K by introducing structural defects with different concentration and configuration by low-temperature reactor irradiation and subsequent annealing. During irradiation the Kohler rule is extremely well satisfied because, in this case, only the concentration of identical defects is enlarged. After step annealing, however, there are large deviations, because the structural defects not only recombine but also rearrange to other configurations, which corresponds to a change in the mean scattering anisotropy. The influence of small-angle scattering can be seen in the measurement curves. (auth)

42468 ON THE DEPTH OF COLORATION PRODUCED BY 25-keV ELECTRONS IN NaCl (110) DIRECTION. Choudhury, A.; Chaudhuri, S.; Goswami, K. (Jadavpur Univ., Calcutta). Phys. Status Solidi, 34: K49-50(July 1, 1969).

A NaCl single crystal was cut along the ⟨110⟩ direction, and F centers were produced by bombarding the crystal with 25-keV electrons. The magnitude of coloration attained saturation after 4.4 min of bombardment. The F-band had half-width and maximum absorption at the peak (470nm) of 0.44 and 0.118 eV, respectively. The depth of coloration was found to be 12×10^{-4} cm. The number of F centers as calculated from Smakula's equation was 1.31×10^{18} cm^{-3}. Results indicate a 56% efficiency of F-center formation along the NaCl ⟨110⟩ direction. (D.H.M.)

42469 IMPURITY EFFECTS ON THE IONIZATION STATES OF F-AGGREGATE COLOR CENTERS IN SODIUM FLUORIDE. Chandra, Ashoka (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys., 51: 1499-1509(Aug. 15, 1969).

A study was made of the F-aggregate color centers produced in NaF crystals by x irradiation at room temperature followed by various thermal and optical bleaching treatments. Crystals used were grown from Harshaw NaF. In addition to undoped samples, crystals were grown with NaOH and Na_2O_2 dopings. Important differences are observed in the doped samples in relation to the charge states of F-aggregate centers. Electron-deficient centers are stabilized, and the probability of their formation is enhanced in hydroxide-doped samples. In peroxide-doped samples, the "extra-electron centers" are favored. Model photochemical reactions are introduced which show the generation of "electron traps" in hydroxide-doped samples and provide excess electrons in peroxide-doped samples. The behavior of the doped samples can be equivalently explained on the band picture in terms of the shift of the Fermi level caused by the introduction of acceptor and donor levels by the doped impurities. The postulated oxidation−reduction effects are supported by observations of impurity effects on relative concentrations of charged and neutral centers after x irradiation, thermal and optical bleaching rates, and reactions involving conversion among various charge states. (auth)

42470 STORED ENERGY IN IRRADIATED SODIUM CHLORIDE. Bunch, James M.; Pearlstein, Edgar (Univ. of Nebraska, Lincoln). Phys. Rev., 181: 1290-7(May 15, 1969).

Irradiated NaCl crystals are heated from room temperature to 400°C, and the energy released is measured by calorimetry. F-center densities range from 3×10^{17} to 1.8×10^{18}/cm^3, which are low enough to be measured directly, rather than inferred. There are three definite peaks in energy release: centered at 135, 250, and 350°C. The 250°C peak is the largest, and is associated with almost all of the coloring changes. The total stored energy is 12.4 eV per F center, of which 8.4 eV is released in the 250°C peak and 2.2 eV is released in the 135°C peak. Assignment of thermal energies to specific atomic processes is difficult, because there are so many processes but only three experimental peaks. Evidence is good that the 250°C peak is mainly a superposition of two unresolved peaks, of which the lower is due to the annealing of the F-center electrons, and the upper to the annealing of vacancies. It is suggested that the 350°C peak comes from the annealing of M-center divacancies. There is no good evidence with which to explain the large amount of energy in the 135°C peak. A calcium-doped crystal also releases energy in three peaks centered at these temperatures, but here most of the energy, and all of the bleaching, occur under the lowest-temperature peak. (auth)

42471 MODIFICATION OF THE SILICON ABSORPTION EDGE BY RADIATION-INDUCED DEFECTS. Fischer, J. E. (Michelson Lab., China Lake, Calif.). Phys. Rev., 181: 1368-9(May 15, 1969).

It is suggested that this phenomenon may be explained by an internal Franz−Keldysh mechanism. (auth)

Physical Properties

Refer also to abstracts 41617, 41992, and 42252.

42472 (AD-682320) ELECTRON AND NUCLEAR SPIN INTERACTIONS IN SOLIDS. Final Report, December 1, 1965-December 31, 1968. Keffer, Frederic (Pittsburgh Univ., Pa. Dept. of Physics). Dec. 27, 1968. 10p. (AFOSR-69-90-TR). CFSTI.

Objectives achieved on this joint experimental and theoretical project include a better understanding of the ferromagnetism arising from interaction between conduction electrons and local moments; magnetocrystalline anisotropy in rare earths; band theory of arsenic, bismuth, and antimony; nuclear spin relaxation; properties of ice; spin diffusion; line shapes, especially relating steady state absorption to free induction decay; and excitation of nuclear spin waves of finite wavelength. (auth)(USGRDR)

42473 (AE-365) ON PHONONS IN SIMPLE METALS. II. CALCULATED DISPERSION CURVES IN ALUMINIUM. Johnson, Rune; Westin, Assar (Aktiebolaget Atomenergi, Stockholm (Sweden)). July 1969. 122p. Dep. CFSTI (U. S. Sales Only).

The real part of the dynamical matrix, derived earlier in a weak local potential ion-electron interaction model of the metal, was investigated in the case of aluminum. It is shown that the free electron, or Lindhard, dielectric function leads to a picture of the metal that is inconsistent with the dHvA observations of the Fermi surface. By adjusting one parameter, however, the experimental phonon frequencies are reproduced satisfactorily. Even some simple structure in the derivative $d\omega/dq$ can be reproduced in this way. Although corrections to the Lindhard dielectric matrix give no essential contributions to the dynamical matrix, the first order corrections, which are the most important, can explain the observed Fermi surface. Much of the observed structure in the phonon dispersion curves seems also to be due to these nondiagonal terms in the dielectric matrix. (auth)

42474 (AEC-tr-6869/8) UKRAINIAN PHYSICS JOURNAL. Translation of Ukr. Fiz. Zh., 12: No. 8, 1233-1399(Aug. 1967). 168p. (TT-67-51421/8; IPST-Cat.-5068). Dep. CFSTI.

42475 (AERE-R-5965) EFFECT OF HIGH PRESSURES ON THE ELECTRICAL CONDUCTIVITY OF PRASEODYMIUM AND SOME PRESEODYMIUM ALLOYS. King, E.; Harris, I. R. (Atomic Energy Research Establishment, Harwell (England)). May 1969. 17p. Dep. CFSTI (U. S. Sales Only). UK 3s.

High-pressure resistivity studies on praseodymium have shown that there is a maximum in the resistance at a pressure of about 40 kB, and high-pressure x-ray diffraction work has shown that this resistance anomaly is associated with a crystallographic transformation from a double-hexagonal to a fcc modification. A study was made of the effect on this behavior of alloying additions of the trivalent rare-earth elements gadolinium, terbium, holmium, and yttrium, and the tetravalent actinide metal thorium, all of which form extensive solid solutions in praseodymium. It was found that the hcp rare-earth metals increase the pressure at which the resistance maximum occurs, stabilizing the dihexagonal structure relative to the fcc form. Face-centered-cubic thorium lowers the pressure at which the resistance maximum occurs, increasing the relative stability of the fcc praseodymium allotrope. (auth) (UK)

42476 (BM-RI-7289) ELECTRICAL RESISTIVITY OF HYPERSTOICHIOMETRIC COLUMBIUM AND ZIRCONIUM CARBIDE MATERIALS AT ELEVATED TEMPERATURES. Paulson, Danton L.; Asai, Gene (Bureau of Mines, Albany, Oreg. Albany Metallurgy Research Center). Aug. 1969. 30p. Bureau of Mines Free.

Elevated-temperature electric resistivity measurements were made on arc-melted, spin-cast, and hot-pressed niobium carbide-carbon (NbC−C) and zirconium carbide−carbon (ZrC−C) materials up to 2,000°C. The NbC−C materials displayed electric resistivity values ranging from 35.20 microhm cm at 23°C for hot-pressed material containing 12 wt % carbon to 242.64 microhm cm at 1622°C for arc-cast material containing 17.0 wt % carbon. Electric resistivity values ranged from 29 microhm cm at 20°C for arc-cast ZrC−C containing 16 wt % carbon to 279 microhm cm at 1951°C for hot-pressed ZrC−C containing 21 wt % carbon. Data from a previous report were included to establish comparison between the electrical resistivities of the NbC−C, ZrC−C, and HfC−C systems. (auth)

42477 (LA-4152) COMPUTER SIMULATION OF LEED PATTERNS FROM THE (111) PLANAR SURFACE OF URANIUM DIOXIDE. I. INITIAL STUDIES. Feber, Roy C.; Grimmer, Derrick P. (Los Alamos Scientific Lab., N. Mex.). Apr. 1969. Contract W-7405-eng-36. 18p. Dep. CFSTI.

Computer calculations were made with three-dimensional models to simulate experimental low-energy electron-diffraction (LEED) patterns from the (111) face of stoichiometric and nonstoichiometric uranium dioxide. Laser-beam diffraction by two-dimensional (111) statistical structures is also simulated. A simple kinematical diffraction analysis is used. The computer results are of particular interest because they suggest that previously unconsidered crystallographic modifications of the UO_2(111) and UO_{2+x}(111) planar surfaces may contribute to the observed diffraction patterns. Agreement between the calculated diffraction features and the LEED results for stoichiometric uranium dioxide requires a model in which the interlayer spacing at the surface differs from that for the bulk lattice. Results for the nonstoichiometric oxide are simulated by a model in which random triads of uranium ions move out of plane. (auth)

42478 (UCRL-18735, pp 153-73) SOLID-STATE PHYSICS. (California Univ., Berkeley. Lawrence Radiation Lab.).

Research concerning the electronic, optical, and magnetic properties of solids, far-infrared properties of solids, nuclear spin interactions, and superconductivity is briefly summarized. Most of the information reported has been published, either in the open literature or reports, and references are given. (L.M.T.)

42479 METAMAGNETISM IN $UP_{0.75}S_{0.25}$. Crangle, J.; Kuznietz, M.; Lander, G. H.; Baskin, Y. (Argonne National Lab., Ill.). J. Phys. C (London), 2: 925-7(May 1969).

Magnetization measurements on a powdered sample of $UP_{0.75}S_{0.25}$ showed the occurrence of a metamagnetic state. Results agreed with the results of a neutron-diffraction study in which ferromagnetic and type-IA antiferromagnetic structures were found at temperatures respectively above and below that of the metamagnetic state. (auth) (UK)

42480 ON THE DIELECTRIC PROPERTIES OF U_4O_9 AND UO_2. Tateno, Jun; Naito, Keiji (Japan Atomic Energy Research Inst., Tokai). Solid State Commun., 7: 807-10(June 1969).

Dielectric properties of U_4O_9 and UO_2 were measured at various temperatures and at various frequencies. From the experimental results the phase transition in U_4O_9 at about 80°C is not considered to be ascribed to dielectric origin. The dielectric constants of both U_4O_9 and UO_2 increase as the temperature increases. (auth) (UK)

42481 ENERGY BAND STRUCTURE OF URANIUM COMPOUNDS WITH NaCl TYPE STRUCTURE. Adachi, Hirohiko; Imoto, Shosuke (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 371-9(July 1969).

Nonrelativistic and relativistic band structures of NaCl-type uranium compounds were calculated with the tight-binding approximation based on the rigid-band concept. The calculations revealed that the narrow 5f band played an important role and, from the density of states curve, the Fermi levels of these compounds were found to lie on or near the 5f band. Moreover, spin−orbit and crystalline field effects were seen to split the 5f band further into five sub-bands. The Fermi levels proved to be related to the lowest sub-band, in which two states were included, and the width of this sub-band was estimated to be 0.05 eV. The validity of the foregoing band structure, based on calculations, is discussed in relation to specific heat at low temperatures and to magnetic properties. (auth)

42482 BAND STRUCTURE AND FERMI SURFACE OF ReO_3. Mattheiss, L. F. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 181: 987-1000(May 15, 1969).

The nonrelativistic augmented-plane-wave (APW) method was applied to calculate the band structure of ReO_3. An important feature of this calculation is that it includes corrections to the usual "muffin-tin" approximation. Because of convergence difficulties, the APW calculation was carried out only at symmetry points in the Brillouin zone. These results were used in conjunction with the Slater−Koster linear-combination-of-atomic-orbitals interpolation scheme to determine the band structure and Fermi surface throughout the Brillouin zone. The Fermi energy occurs in the t_{2g} manifold of the rhenium 5d bands. The calculation predicts a Fermi surface consisting of two closed electron sheets centered about Γ, plus a third electron sheet which is open along ⟨100⟩. The tight-binding parameters, which affect both the oxygen−rhenium (2p−5d) energy separation and the corresponding bandwidths, were adjusted to fit the optical and Fermi-surface data for ReO_3. Spin−orbit effects for the rhenium 5d bands have been included by means of a spin−orbit parameter ξ_{5d}. The optimum value for this parameter has been determined by detailed comparisons between the theoretical and experimental Fermi-surface areas. The final results agree to within 10%. (auth)

42483 THEORY OF THE SCATTERING OF NEUTRONS BY MAGNETIC IONS IN CRYSTALS. Johnston, D. F.; Rimmer, D. E. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London), 2: 1151-67(July 1969).

By expanding the magnetic interaction between neutrons and electrons in terms of irreducible tensor operators a general expression for the coherent elastic scattering cross section is obtained. This can allow for the use of polarized beams and any scattering vector. If an orbital moment is present, its effect is automatically included. This approach leads to results which are identical to those obtained by traditional methods, but the formalism is more compact and better suited to programming for computer calculations. Examples of the results from such a program are discussed, illustrating its use as an experiment simulator. By surveying the output produced by various feasible arrangements and likely wave functions it should be possible to discover the critical experiments which are worth undertaking. (auth) (UK)

42484 ENHANCED KORRINGA-LIKE RELAXATION IN STRONGLY PARAMAGNETIC RARE EARTH−HYDROGEN ALLOYS. Shen, L. (Northwestern Univ., Evanston, Ill.); Kopp, J. P.; Schreiber, D. S. Phys. Lett., 29A: 438-9(June 30, 1969).

The proton nuclear spin−lattice relaxation time in several strongly paramagnetic rare earth−hydrogen alloys are found to obey a relation of the form $T_1T \propto (T-\Theta)^2$. Such a relation is shown to be consequence of assuming a generalized Korringa relation when taking into account the temperature dependence of the Knight shift. (auth)

42485 NEUTRON CRITICAL SCATTERING IN IRON WITH VERY HIGH TEMPERATURE STABILITY. Ciszewski, R. (Warsaw Tech. Univ.); Blinowski, K. Phys. Lett., 29A: 513-14(July 28, 1969).

Neutron small-angle scattering for different temperatures with ± 0.1°C temperature stability was determined, using neutrons of 1.14 Å wavelength. Predicted by J. Kocinski's theory, some diffraction maxima were found. (auth)

42486 MAGNETIC PROPERTIES OF Au_4V. Besnus, M. J. (Institute de Physique, Strasbourg). Phys. Lett., 29A: 516-17 (July 28, 1969).

Ordered Au_4V has a coercive force of 23 kOe at 4.2°K. The paramagnetic susceptibility includes, beside the Curie–Weiss term, a Pauli paramagnetism contribution. A ferromagnetic moment of $0.80\,\mu_B$/V at. deduced from a localized model agrees with some experimental values. (auth)

42487 MAGNETIC PROPERTIES OF U_3P_4 AND U_3As_4 SINGLE CRYSTALS. Buhrer, C. F. (General Telephone and Electronics Lab., Bayside, N. Y.). J. Phys. Chem. Solids, 30: 1273-6(May 1969).

Studies of the magnetic properties of U_3P_4 and U_3As_4 powders have led to the conclusion that these uranium compounds are ferromagnetic at low temperatures, and this has been supported in the case of U_3P_4 by a neutron-diffraction study. However, the discrepancy between the paramagnetic and ferromagnetic moments in U_3P_4 (2.77 μ_B and 1.16 μ_B per U ion, respectively) and the low value found for the entropy change associated with its magnetic ordering suggest that these compounds may not be simple ferromagnets. In this study, magnetic measurements were made on single crystals of these compounds. The results show the existence of an extremely large magnetocrystalline anisotropy with the easy axis of magnetization along a [111] direction in the cubic unit cell. In addition, toroids of U_3P_4 ceramic were used for hysteresis studies which established the presence of a zero-field magnetization. (auth) (UK)

42488 ELECTRICAL AND OPTICAL PROPERTIES OF SPUTTERED CdO FILMS. Tanaka, Kuniaki (Tokyo Univ. of Agriculture and Tech.); Kunioka, Akio; Sakai, Yoshio. Jap. J. Appl. Phys., 8: 681-91(June 1969).

CdO films were prepared by a dc reactive sputtering method with various sputtering voltages. The characteristics of the films were compared by reflection electron diffraction and x-ray diffraction patterns. The effects of sputtering voltage and partial pressure of oxygen on the electron densities and the Hall mobilities were investigated. Observations on lattice parameters lead to the conclusion that CdO films with high carrier concentrations contain excess interstitial Cd atoms. The absorption edge variation of annealed films prepared by high-voltage sputtering agrees with the theoretical curve, which is calculated from the Fermi level shift caused by the change in carrier concentrations. (auth)

42489 CALCULATION OF THE PROPERTIES OF VACANCIES AND INTERSTITIALS. Proceedings of a Conference, Skyland, Va., May 1–5, 1966. National Bureau of Standards Miscellaneous Publication 287. Washington, D. C., National Bureau of Standards, 1966. 208p. (NBS-MISC. PUBL.-287; CONF-660529). GPO $2.50.

The conference dealt with the theory and techniques of calculation of the properties of point defects in metallic and nonmetallic crystals. The contributed and invited papers divided about evenly among three major topics: (1) static-lattice calculations of the energies and configurations of simple vacancies and interstitials in, mainly, metals and ionic crystals; (2) electronic states at and near point defects in metals, rare gas solids, and insulators (F centers, electron traps); and (3) vibrational states at point defects. The report of a panel discussion on each topic is also included. The emphasis is on the theory of the properties of isolated, simple defects rather than on the statistical properties of defect assemblies. The conference attempted to examine the point defect theory and calculations critically, from the standpoint of general theory, rather than simply compare results with experiment. (TSS)

42490 OPTICAL AND PHOTOELECTRIC PROPERTIES OF β-RHOMBOHEDRAL BORON. I. OPTICAL CONSTANTS, BAND EDGES, AND ABSORPTION-FREE CHARGE CARRIERS. Jaumann, J.; Werheit, H. (Univ., Cologne). Phys. Status Solidi, 33: 587-98(June 1, 1969). (In German).

The temperature dependence of the absorption spectrum from the edge to the inset of the lattice vibrations can be described by indirect band–band transitions and excitations from a thermally occupied trap level, the existence of which was proved by illumination at low temperatures changing the absorption and photoconductivity spectrum importantly. Free carrier absorption superimposed on the lattice spectrum was found at high temperatures. Its increase proportional to λ^3 suggests scattering by charged centers. Their density is about 5×10^{20} cm^{-3} surpassing impurities by a factor of 10^2. The effective mass of holes is estimated at 8 m_0 corresponding to a conductivity by hopping processes. The complicated lattice vibration spectrum is nearly independent of temperature between 4 and 13 μm indicating that there are no combination bands. (auth)

42491 CALCULATION OF VACANCY MIGRATION ENERGIES IN ALUMINUM AND LITHIUM. Torrens, I. M.; Gerl, M. (CEN de Saclay, Gif sur Yvette, France). Radiat. Eff., 1: 55-60 (Jan. 1969).

Migration energies of vacancies in aluminum and lithium were calculated using an interatomic potential determined by an OPW pseudopotential method. This differs from potentials of the Born–Mayer and Morse types in that it is an oscillating potential, taking into account directly the ion–electron–ion interactions and stability of the crystal. The method of calculation is that of computer simulation of a section of lattice containing the vacancy in different stages of its migration, convergence, and kinetic disturbance propagation criteria determining the volume of lattice permitted to relax around the defect. The effect of the oscillating potential is described and the results are reviewed in the light of its relative accuracy in the two metals chosen. (auth)

42492 THERMODYNAMIC EQUILIBRIUM OF POINT DEFECTS IN SINTERED CdO. Jarzebski, Z. M. (Academy of Mining and Metallurgy, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 215-19(1969).

Measurements of the Hall effect in CdO as a function of temperature made previously showed that a state close to equilibrium of CdO with ambient oxygen can be obtained at temperatures above 900°K after 5 hr. Studies were made to establish at which temperature this equilibrium can be reached after a relatively short time. The resistivity and the Seebeck coefficient in CdO were measured at room temperature as a function of time of heat treatment under varying oxygen pressures. In order to elucidate the sintering process of CdO, the specific surface area of this material was measured. The results showed that at 1000°K both resistivity and Seebeck coefficient in CdO may vary reversibly with the change of oxygen pressure. It seems, therefore, that in the case of CdO sintered at 1000°K for 12 hr, the effects of intercrystalline contact resistances is constant and not dependent on the time of heating. For the partial oxygen pressure of 1.6×10^{-2} mm, equilibrium was attained after 2 hr, whereas for 150 mm equilibrium was attained after 24 hr. (P.C.H.)

42493 HALL EFFECT AND ELECTRIC CONDUCTION IN CADMIUM OXIDE. Jarzebski, Z. M. (Academy of Mining and Metallurgy, Krakow). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 17: 221-4(1969).

Studies were made on the concentration of conduction electrons and their mobility as a function of the temperature in the range in which CdO can be equilibrated with ambient atmosphere within a reasonable time of heating. The results showed that at temperatures above 900°K, the temperature dependence of electron concentration in CdO is in agreement with the mass action theory of point defects. The activation energy of the defects was found to be 0.75 eV. It was also found that the conduction electrons in CdO are scattered mainly by ionized point defects. (P.C.H.)

42494 THERMAL AND ELECTRICAL CONDUCTIVITIES OF SOME ALLOYS AT LOW TEMPERATURES. Srivastava, B. N.; Chatterjee, S.; Sen, S. K. (Indian Association for the Cultivation of Science, Calcutta). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 1-6(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210–(Vol.3).

The lattice conductivity of alloys containing trivalent solute indium in copper solvent was studied. Thermal and electric conductivities were measured at 16 to 90°K. The electron and phonon components of thermal conductivity were plotted and the residual electric resistivity calculated. The electronic and lattice parts of the conductivity were determined. (M.C.G.)

42495 MAGNETIC STUDIES OF URANIUM OXALATE, FORMATE, ACETATE, AND THEIR RESPECTIVE OXYSALTS. Dutta Roy, S. K.; Ghosh, B.; Sahoo, B. (Indian Inst. of Tech., Kharagpur, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 191-5(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210–(Vol.3).

An expression was derived for the principal susceptibility of U^{4+} ions in which the crystal field and exchange effects are included. Results are summarized for uranium oxalate, formate, acetate, oxyoxalate, oxyformate, and oxyacetate. (M.C.G.)

42496 STUDY OF NEAR-IDEAL GRAPHITE. Goswami, K. N. (Regional Research Lab., Jorhat, India). Proc. Nucl. Phys. Solid State Phys. Symp., Bombay, 1968, 3: 309-14(1968).

From Nuclear Physics and Solid State Physics Symposium, Bombay, India. See CONF-681210-(Vol.3).

An attempt to index the x-ray pattern of coal in terms of graphite is discussed. Results indicated a random layer structure in which graphite layers are stacked roughly parallel and equidistant, but each layer has a completely random orientation about the layer normal. Experiments were carried out with carbon black prepared from Assam coal. (M.C.G.)

42497 BEHAVIOR AND MECHANISM OF THE ALLOTROPIC TRANSFORMATION OF CERIUM. Shimura, Kazuteru (Virginia Polytechnic Inst., Blacksburg, Va.). Jap. J. Appl. Phys., 8: 870-5(July 1969).

When cerium is subjected to the thermal cycling between room and liquid air temperatures, the amount of α phase increases after each cycle as the electrical resistance changes accordingly, where the changing manners of both factors are quite similar. However, although terminal temperatures of the thermal cycling are far different from the transformation temperature, the amount of phase change never attains 100%, but a certain equilibrium value. The transformation mechanism of cerium was discussed theoretically, while an attempt was made to give a theoretical explanation upon the above mentioned attainment of an equilibrium, utilizing the theory of martensite formation in carbon steel by Cohen, et al., considering the size effect due to the subdivision of crystal grains by the formed martensite leaves. (auth)

42498 MEASUREMENTS OF THERMAL CONDUCTIVITY OF METALS IN TEMPERATURE RANGE FROM 1100° TO 2500°K. Emel'yanov, A. A.; Kraev, O. A.; Stel'makh, A. A.; Fomin, R. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 154-5(May-June 1969). (In Russian).

Descriptions are given of a method for measuring heat conductivity of metals at 1100 to 2500°K. Data on thermal conductivity of Ta, Mo, Nb, V, and Co are included. (R.V.J.)

42499 INVESTIGATION OF THE THERMOELECTROMOTIVE FORCE AND THERMOMAGNETIC EFFECT IN DYSPROSIUM. Kondorskii, E. I.; Galkina, O. S.; Markov, P. A.; Borovikov, Yu. M. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 57: 130-1(July 1969). (In Russian).

The thermoelectromotive force and thermomagnetic effect in dysprosium are investigated as a function of magnetic field strength up to 38.5 kOe at temperatures between 90 and 190°K. It is found that in strong magnetic fields and at the indicated temperatures the thermo-emf is a weak function of temperature. The critical field for which a sharp change of the thermoelectromotive force occurs are the same as those in which magnetization, increases as a result of transition from the antiferromagnetic to ferromagnetic state. (auth)

42500 MAGNETIC PROPERTIES OF USb_2–$ThSb_2$ SOLID SOLUTIONS. Chechernikov, V. I.; Kuz'min, R. N.; Chachkhiani, L. G.; Golovnin, V. A.; Irkaev, S. M.; Slovyanskikh, V. K.; Shavishvili, T. M. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 57: 125-9(July 1969). (In Russian).

Solid solutions of the USb_2–$ThSb_2$ system were synthesized and the magnetic properties investigated at various temperature (80 to 700°K). It was found that solutions containing <0.5 $ThSb_2$ are antiferromagnetic; the Neel temperature shifts toward lower temperatures with increase of the $ThSb_2$ content. The effective number of Bohr magnetons μ_{eff}, magnetic Curie temperature Θ_p and lattice parameters were determined for all compositions. A suggestion regarding the ground energy state of the U ion is made. (auth)

42501 DETERMINATION OF THE CURIE TEMPERATURE OF A REAL SAMPLE. Voronel, A. V.; Garber, S. R.; Peretsman, L. D. Zh. Eksp. Teor. Fiz., 57: 92-9(July 1969). (In Russian).

The specific heat, effective permeability and loss resistance of three gadolinium samples are measured near the Curie temperature. It is found that peaks of all three quantities do not occur at the same temperatures. The temperature of the permeability peak is closer to the Curie temperature than the temperature of the specific heat maximum. It is suggested that the most precise information regarding the Curie temperature of a perfect sample can be obtained by measuring the loss resistance. The dependence of permeability and losses on the temperature is found to be of a hysteresis nature and the maxima of these quantities depend on frequency. (auth)

42502 EFFECT OF IMPURITIES ON THE TOPOLOGY OF THE FERMI SURFACE OF INDIUM. Makarov, V. I.; Volynskii, I. Ya. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 57: 3-12(July 1969). (In Russian).

Binary and ternary In solid solutions with Sn, Pb, Cd, or Hg are studied. The quantity of dT_K/dP as a function of impurity concentration is found to have a maximum. This type of dependence indicates that the topology of the Fermi surface in indium is modified by the impurity. (auth)

42503 SEMICONDUCTOR PROPERTIES OF ANODICALLY PRODUCED OXIDE LAYERS ON NIOBIUM. Stuetzle, D.; Heusler, K. E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Phys. Chem. (Frankfurt), 65: 201-15(May 1969). (In German).

Anodic niobium oxide on niobium was found to behave as a weakly dissociated impurity semiconductor. The potential dependence of the capacitance can be described by the Mott-Schottky relation in a potential region where the space charge layer is much thinner than the oxide layer. The donor density in the oxide layer decreases inversely with the square of the distance from the metal interface. The interfacial potential at the phase boundary between the oxide and the electrolyte was influenced by adsorption of various components of the electrolyte. The strong frequency dependence of the space charge capacitance may be interpreted by slow dissociation of donors. The field-dependence of the electronic conductivity is described by the anomalous Poole-Frenkel effect. From the temperature dependence of conductivity, the energy level of the donors with respect to the conduction band is estimated. (auth)

42504 MAGNETIC PROPERTIES OF UP–US SOLID SOLUTIONS. Trzebiatowski, W.; Palewski, T. (Inst. of Low Temperature and Structure Research, Wroclaw. Technical Univ., Wroclaw). Phys. Status Solidi, 34: K51-4(July 1, 1969).

Lattice constants and magnetic moments of UP–US solid solutions are presented that are in good agreement with previously published results. The transition from the anti- to the ferromagnetic state proceeds within a rather narrow composition interval between 15 and 20 mol% US. Samples containing 0 to 15% US are antiferromagnetic, but a field dependence of the susceptibility at US contents above 10 mol% is observed. (D.H.M.)

42505 MAGNETIC PROPERTIES OF $DyPt_3$ AND $DyIn_3$. Arnold, G.; Nereson, N. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 51: 1495-9(Aug. 15, 1969).

Neutron-diffraction measurements made on powder samples of the intermetallic compounds, $DyPt_3$ and $DyIn_3$, show that these compounds exhibit antiferromagnetic ordering below Néel temperatures of 13.2° ± 0.3°K and 24° ± 0.5°K, respectively. The magnetic reflections from $DyPt_3$ can be indexed on a doubled chemical cell of cubic symmetry. A suitable magnetic model consists of an arrangement where the Dy moments are aligned in opposite directions in adjacent (111) magnetic planes. For $DyIn_3$, the magnetic reflections can be indexed on the doubled chemical cell of tetragonal symmetry. An appropriate magnetic model is one in which the Dy moments are aligned oppositely in adjacent (110) magnetic planes. The moment direction makes an angle of 27° ± 5° with the unique axis of the tetragonal magnetic cell. The saturated ordered moment is $9.0 \pm 0.3\ \mu_B$ per Dy atom for $DyPt_3$ and $8.8 \pm 0.3\ \mu_B$ per Dy atom for $DyIn_3$. The magnetic ordering process as a function of temperature closely follows a Brillouin function for $DyPt_3$; the $DyIn_3$ ordering shows a deviation from the customary behavior. The magnetic form factor data from the coherent magnetic reflections agree well between the two compounds but decrease faster with increasing scattering angle than theoretical predictions. (auth)

Moessbauer Effects and NMR

42506 (CEA-R-3706) PROGRESSIVE- AND RESONANT-WAVE HELICES: APPLICATION TO ELECTRON PARAMAGNETIC RESONANCE. Volino, Ferdinand (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1969. 110p. (In French). Dep.

It is shown that helices can be used as resonant systems. Their properties are theoretically and experimentally studied. Resonant helices for electron paramagnetic resonance in the X band are described, and their sensitivity and the sensitivity of a normal resonant cavity are compared. For cylindrical samples less than 3 mm in diameter, the helix is more sencitive and can produce more intense microwave magnetic fields. (auth)

42507 HYPERFINE FIELDS ON HAFNIUM NUCLEI IN IRON AND GADOLINIUM METAL. Murnick, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Huefner, S.; Herskind, B. Z. Phys., 226: 175-81(1969).

The recoil implantation perturbed angular correlation technique, IMPACT, was used to study the hyperfine interaction in ^{180}Hf in iron and gadolinium. The perturbed angular correlation through the Coulomb excited 4^+ state was used, thus minimizing the effect of quadrupole interactions. The effective hyperfine fields on Hf in iron and gadolinium were determined to have the same sign, negative, and magnitudes of (507 ± 60) kOe and (304 ± 31) kOe, respectively. Results are compared with values reported from several other experiments ostensibly measuring the same quantity. Problems inherent in the various experimental techniques are considered. (auth)

42508 RECOILLESS FRACTION AND THERMAL SHIFT OF ^{182}W AND ^{183}W. Raj, D.; Puri, S. P. (Roorkee Univ., India). Phys. Lett., 29A: 510-11(July 28, 1969).

The recoilless fractions of ^{182}W and ^{183}W were calculated over the temperature range 4 to 300°K on the basis of experimentally determined phonon frequency distribution function, as well as the one on Krebs' model. There is reasonable agreement between the experimental values and calculations. In addition, the thermal shift values for these isotopes, have also been computed. (auth)

42509 NUCLEAR SPIN RELAXATION OF HYDROGEN IN THORIUM HYDRIDES. Will, Jerald Duane. Contract W-7405-eng-82. Ames, Iowa, Iowa State Univ., 1968. 101p. (IS-T-252). Thesis.

Hydrogen nuclear spin relaxation in the two distinct thorium hydride phases (ThH_2, Th_4H_{15}) was studied as a function of temperature in the temperature regions where hydrogen diffusion provides the dominant relaxation mechanism (173°C to 470°C for ThH_2, 78°C to 470°C for Th_4H_{15}). Pulsed nuclear magnetic resonance measurements of the hydrogen spin-lattice and spin-spin relaxation times at a resonance frequence of 10.5 MHz were interpreted in terms of existing translational diffusion parameters and mechanisms. Activation energies determined for the two ThH_2 samples studied, which have a face-centered tetragonal metal lattice, are 18.3 kcal/mole for the hydrogen-to-metal ratio H/Th ~ 1.8 and 16.2 kcal/mole for H/Th ~ 2.1. For this phase, the diffusion mechanism indicated is that of hydrogen jumps between tetrahedral interstitial positions and nearest-neighbor octahedral interstitial positions. In ThH_2 there is evidence for an additional relaxation mechanism with a spin-lattice relaxation time given by α/T where $\alpha = 238$ seconds - °K. In addition, negative fractional shifts on the order of 10^{-4} were determined in the hydrogen resonance frequencies at constant magnetic field. Relaxation measurements in the two Th_4H_{15} samples are complicated by the fact that the relaxation times at a particular temperature depend upon the maximum temperature to which the samples were previously raised. The relaxation data taken for temperatures below a maximum temperature, after the samples have experienced the maximum temperature, are predicted satisfactorily by theory when it is assumed that those hydrogens in one of the two crystallographically inequivalent sites in the complex bcc structure of this compound do not diffuse whereas those hydrogens in the other site make jumps between nearest-neighbor positions of that type. (Disser. Abstr.)

42510 ^{125}Te MOESSBAUER EFFECT STUDY OF NEUTRON CAPTURE EFFECTS IN PbTe, Te, AND TeO_2. Ullrich, J. F.; Vincent, D. H. (Univ. of Michigan, Ann Arbor). J. Phys. Chem. Solids, 30: 1189-95(May 1969).

The Mössbauer emission spectra of ^{125}Te in PbTe, Te metal, and TeO_2 were measured following neutron capture in ^{124}Te. Mössbauer data for each sample were taken after source irradiation and following thermal annealing. The irradiation conditions were chosen so that only the thermal neutron capture induced defects should have a significant effect on the environment of the Mössbauer emitting nuclei. Comparison of the data taken before and after source annealing showed no differences in linewidth, isomer shift, quadrupole splitting, or resonance intensity within the standard deviations of the parameters. The results show that the thermal neutron capture process in ^{124}Te does not affect the ^{125}Te Mössbauer spectra. The possible reasons for this are discussed. The results also indicate that the anomalous isomer shift reported by Stepanov and Aleksandrov (1967) in a similar experiment on PbTe was probably caused by a high background of fast neutron induced displacements. (auth) (UK)

42511 MOESSBAUER SPECTROSCOPY WITH MONOCHROMATIC CIRCULARLY POLARIZED RADIATION. Shtrikman, S.; Somekh, S. (Weizmann Inst. of Science, Rehovot, Israel). Rev. Sci. Instrum., 40: 1151-3(Sept. 1969).

A technique for carrying out Moessbauer experiments with monochromatic polarized radiation is described. Moessbauer spectra of longitudinally magnetized yttrium iron garnet employing circularly polarized radiation are given. (auth)

42512 NUCLEAR MAGNETIC RESONANCE STUDY OF FERROMAGNETIC β_1-MnZn. Hihara, Tadamiki; Kasaya, Mitsuo; Koi, Yoshitaka (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 27: 329-32(Aug. 1969).

With the hope of obtaining information about the canted spin structure which has been proposed by Nakagawa et al., on the basis of their neutron diffraction study, the ^{55}Mn NMR frequency has been measured as a function of external magnetic field. A value of (-1.03 ± 0.03) MHz/kOe has been obtained for $d\nu/dH$ at 77°K. This value seems to suggest that β_1-MnZn has a simple ferromagnetic spin structure, if it is not the case that the hyperfine field at the ^{55}Mn nucleus lies accidentally along the ferromagnetic component due to the effects of the neighboring Mn moments. The results of the observation of the ^{91}Zr NMR is appended. The hyperfine field at the ^{67}Zn nucleus is -270.9 kOe at 4.2°K. (auth)

42513 IMPURITY NUCLEAR-MAGNETIC-RESONANCE SHIFTS AND SPIN-LATTICE RELAXATION RATES IN Al:V, Al:Cr, AND Al:Mn. Narath, Albert; Weaver, H. T. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett., 23: 233-6 (Aug. 4, 1969).

Low-temperature (1.3 to 4.0°K) nuclear resonance shifts and spin-lattice relaxation rates of dilute "nonmagnetic" ^{51}V, ^{53}Cr, and ^{55}Mn impurities in aluminum are compared against similar data for the "magnetic" alloys Au : ^{51}V and Mo : ^{59}Co. It is shown that no essential differences exist between the two types of alloy systems. (auth)

42514 MAGNETIC RESONANCE AT THE SOLID STATE PHYSICS AND MAGNETIC RESONANCE SERVICE IN SACLAY. Bull. Inform. Sci. Tech. (Paris), No. 137, 3-18(May 1969). (In French).

A laboratory working on magnetic resonance applied to solid state physics was created in Saclay some twelve years ago. This article describes the main fields of research which have been explored and gives an account of the main results obtained in each of them at Saclay. The main chapters are semi-conductors, Overhauser effect, nuclear polarization, spin temperature, nuclear antiferromagnetism, metals, helium 3. (auth)

Theory

42515 SOLID STATE PHYSICS. VOLUME I. ELECTRONS IN METALS. Cochran, J. F.; Haering, R. R. (eds.). The Simon Fraser University Lectures. New York, Gordon and Breach Science Publishers Inc., 1968. 396p. $24.50.

Information is presented on: electrons in strong magnetic fields the deHaas-van Alphen effect; resonances both temporal and spatial; magnetic-field induced surface quantum states in metals; the Fermi surface program; electronic structure of semimetals and degenerate semiconductors; and alloys, intermetallic compounds, and the experimental study of Fermi surfaces. (P.C.H.)

Theoretical Physics

Refer also to abstracts 41817 and 42719.

42516 (UCRL-50643) TWO-DIMENSIONAL POWER SERIES APPROXIMATION OF EQUATION-OF-STATE SURFACES. Richter, H. P. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 16, 1969. 9p. Dep. CFSTI.

A method based on a two-dimensional power series is shown to be superior to other methods for approximating equation-of-state surfaces. Its major advantage is that it yields a single set of coefficients valid over the entire surface, rather than multiple sets each valid in only a restricted zone. The method is illustrated by applying it to a surface, defined by a compression curve and three release isentropes, obtained from shock experiments on reconstituted tuff (an earth material). All points examined on this experimental surface are approximated to within a few percent, the majority within 1 percent. An outline is given for applying the two-dimensional power series method to evaluation of theoretically derived equations of state. (auth)

42517 RELATIVISTIC BOUND-STATE PROBLEM. Lu, P. (Arizona State Univ., Tempe). Nuovo Cim., Lett., 2: 135-6 (Aug. 1, 1969).

Previously (1968) a formula concerning the energy levels of a modified WKB method of the Schrödinger equation was presented. An example in another note (1969) indicated that the successive terms in the expansion against $\hbar$ in this modified WKB method will give the correct energy eigenvalues of the Balmer formula. This indicated that the higher-order terms in $\hbar$ are important. The approximation is used here in the spirit of Miller and Good (1953). A similar formula is developed concerning the bound-state eigenvalue problem for the Dirac radial equation. (W.D.M.)

42518 APPROXIMATION REPRESENTATION OF THE BOLTZMANN COLLISION INTEGRAL BY AN OPERATOR OF THE FOKKER-PLANCK TYPE. Kas'yanov, V. A. Ukr. Fiz. Zh., 14: 846-9(May 1969). (In Russian).

In contrast to the Moreau-Salmon approximation for the case when the "test" particle mass is many times as small as that of equilibrium "reservoir" particles, an approximate expression is obtained for the operator of the Fokker-Planck type for the collision integral when a heavy "test" molecule moves in an equilibrium gas of light molecules. The structure of the operator obtained is shown to differ from that of the Moreau-Salmon operator. (auth)

42519 CORRESPONDENCE IDENTITIES. I. Norcliffe, A.; Percival, I. C. (Univ. of Stirling, Scotland). J. Phys., B (London), 1: 774-83(Sept. 1968).

The complete quantum-dynamical solutions for a free particle moving in one dimension and for a free particle moving on a ring are obtained in terms of classical path sums. The propagators and Green operator kernels, and, in particular, the kernel of the spectral operator $I_E = \delta(E-H)$ are expressed explicitly in this way. Relations between quantum and classical mechanics that hold for low quantum numbers and relatively small values of the classical action are discussed. They are the correspondence identities. (auth)

42520 LAGRANGIAN FORM OF STOCHASTIC EQUATIONS AND QUANTUM THEORY. De la Pena-Auerbach, L. (Univ. Nacional de Mexico, Mexico City); Cetto, Ana M. Phys. Lett., 29A: 562-3(July 28, 1969).

Further developments of the stochastic approach to quantum mechanics are presented. The basic equations are given in Lagrangian form; the total electromagnetic force is derived and used to obtain Schrödinger's equation with minimal electromagnetic coupling. (auth)

42521 THE GROWTH OF DISCONTINUITIES IN RELATIVISTIC GAS DYNAMICS. McCarthy, Matthew F. (Princeton Univ., N. J.). Int. J. Eng. Sci., 7: 209-16(Feb. 1969).

A relativistic theory of the growth of second-order discontinuities in a perfect gas is given. Results generalizing the classical gas-dynamical relations are derived. The technique employed may be used to study nonlinear wave phenomena in all branches of relativistic continuum mechanics; however, only the perfect gas is studied in detail here since this is the simplest nonlinear material. The general theory of relativistic continuum mechanics formulated by Grot and Eringen was used as a basis for this study. The basic equations, appropriate to a perfect gas, are reviewed, and the compatibility conditions on a time-like hypersurface are considered. It is shown how the δ time derivative may be used in the context of special relativity. A brief account is given of weak waves (i.e. time-like hypersurfaces across which the first partial derivatives of the 4 velocity are discontinuous). The derivation of an equation which determines the variation of the amplitude of a discontinuity, as its associated wave front traverses the material, is provided. It is assumed that the gas is in a uniform state before the arrival of the wavefront and, by choosing the frame of reference to be the rest frame of the uniform state, a particularly simple growth equation are discussed for wavefronts of various shapes. In particular, it is shown that, in certain circumstances, the amplitude of the wave may become unbounded. (BBB)

42522 NUMERICAL ALGORITHM FOR SOLVING NONLINEAR SINGULAR INTEGRAL EQUATIONS THAT ARISE IN CONNECTION WITH MANY-BODY PROBLEMS. Bloomfield, P. E. (Univ. of Pennsylvania, Philadelphia); Sievert, P. R. Phys. Lett., 29A: 447-8(June 30, 1969).

A method is given for transforming nonlinear singular integral equations that arise in connection with finite-temperature many-body problems into a set of algebraic equations to be solved numerically. The method can be used with either Fermi-Dirac or Bose-Einstein statistics, and it can be made arbitrarily accurate. (auth)

42523 EFFECT OF A CONSTANT MAGNETIC FIELD ON THE BETA DECAY RATE OF A NEUTRON IMMERSED IN A COMPLETELY DEGENERATE ELECTRON GAS. O'Connell, R. F.; Matese, J. J. (Louisiana State Univ., Baton Rouge). Phys. Lett., 29A: 533-4(July 28, 1969).

Previous work on the effect of a constant magnetic field on neutron decay in a vacuum is extended to the case where the process takes place in dense bodies (white dwarfs, neutron stars), at zero temperature. (auth)

42524 FORMATION OF BEAMS OF CHARGED PARTICLES WITH TRANSVERSE ENERGY. Jancarik, J. (Inst. of Plasma Physics, Prague). pp 584-9 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th-12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

The motion of charged-particle beams in magnetic fields is theoretically studied. The design of an electron gun capable of forming beams with variable transverse energy and a variable spread of magnetic moments is discussed. (M.O.W.)

42525 PROBLEMS OF STATISTICAL PHYSICS IN STRONGLY EXTENDED BODIES. Tyupkin, Yu. S.; Shvarts, A. S. (Moscow Engineering-Physics Inst.). Dokl. Akad. Nauk SSSR, 185: 299-301(Mar. 11, 1969). (In Russian).

From considerations of an ideal Bose gas, it has been concluded that in strongly extended samples (films and needles) superfluidity and superconductivity begin at lower temperatures than in cubic bodies. This reasoning is at least doubtful. First, it can be proved that for an ideal Bose gas the limit of all thermodynamic functions in a box with one side whose length approaches infinity is the same as in a cubic box. In particular, the phase transition temperature determined from thermodynamic functions does not depend on the way in which the volume of the box approaches infinity. Furthermore, it is shown that on introducing an infinitely small perturbation into the Hamiltonian, the spectrum of the elementary excitations does not depend on the way in which the dimensions of the box approach infinity. Hence the problem of the dependence of the spectrum of elementary excitations on the dimensions of the box must remain open in the general case. (TTT)

42526 INTRODUCTION TO THE PRINCIPLES OF QUANTUM MECHANICS. Simons, S. Logos Press Limited Scientific Publications. New York, Plenum Press, 1968. 123p.

Topics include the physical foundations of quantum mechanics, the single particle time-dependent Schroedinger equation, solution of the time-independent Schroedinger equation, quantum mechanics of many-particle systems, electron spin and identical particles, and perturbation theory. (W.H.K.)

42527 STATISTICAL PHYSICS. Second Revised and Enlarged Edition. Landau, L. D.; Lifshitz, E. M. Course of Theoretical Physics, Volume 5. New York, Pergamon Press, 1968. 493p. £6. $14.50.

Translated from the Russian by J. B. Sykes and M. J. Kearsley.

Topics include the fundamental principles of statistical physics, thermodynamic quantities, the Gibbs distribution, ideal gases, the Fermi and Bose distributions, the condensed state, non-ideal gases, phase equilibrium, solutions, chemical reactions, properties of matter at very high density, fluctuations, the symmetry of crystals, phase transitions of the second kind, and surfaces. (W.H.K.)

42528 COULOMB SCATTERING IN N-DIMENSIONAL SPACE. Peterkop, R. K.; Shkele, M. P. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 2, 7-14(1969). (In Russian).

The Schrödinger equation for the multidimensional Coulomb problem is discussed. The solutions having an asymptotic of "incident + outgoing wave" are obtained. Corresponding equations of classical mechanics—the Hamilton-Jacobi and the continuity of flux equations—are also resolved. The quantum and the classical differential cross sections of scattering are equal only in the three-dimensional case. The obtained multidimensional Coulomb wave functions are applied to the problem of ionization. The limiting transition in the integral expression of the ionization amplitude is found to give various results if different combinations of the Coulomb function are used. (auth)

42529 ELEMENTS OF ADVANCED QUANTUM THEORY. Ziman, J. M. Cambridge, Eng., University Press, 1969. 271p. 55s.

The subject is treated under the following main headings: Bosons; fermions; perturbation theory; Green functions; aspects of many-body problem; relativistic formulations; algebra of symmetry. (UK)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstracts 41066, 42009, and 42617.

42530 (ORNL-tr-2174) EXPERIMENTAL STUDY OF THE PROCESS OF PRODUCTION OF ELECTRON–PHOTON SHOWERS AT ENERGIES RANGING FROM 1 TO 2 GeV. Ogrzeval'skii, Z.; Strugal'skii, Z. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P1-4077. 16p. Dep. CFSTI.

In order to obtain information about the production of cascades in a substance and in particular information about the fluctuations of the mean characteristics of this process photographs of such showers obtained in a xenon bubble chamber were analyzed. There were 36 showers with a total energy $E_\gamma = 1500 \pm 225$ MeV, 40 showers having a total energy $E_\gamma = 1000 \pm 100$ MeV, and 16 showers with $E_\gamma = 2000 \pm 300$ MeV studied. Quantitative information on the number of particles at the maximum of the studied showers, the positions of the maxima of shower development, the mean lengths of development of the cascades, and the fluctuations of the mean characteristics for a given depth t, are shown. From a comparison of the cascade curves corresponding to the different values E_γ and calcalculated, it is concluded that the fluctuations of the number of particles are minimal in the region of the maximum of the shower development, and that the scatter of the conversion lengths influences the course of fluctuations only for $t < t_{max}$. (J.F.P.)

42531 QUASI-ELASTIC ELECTRON–DEUTERON SCATTERING. Budnitz, Robert Jay. Cambridge, Mass., Harvard Univ., 1968. 263p.

Thesis.

The differential cross section for inelastic electron–deuteron scattering was measured at the Cambridge Electron Accelerator in the four-momentum-transfer region from 7 to 115 fermis^{-2} (.27 to 4.47 (BeV/c)^2). The method used involved a coincidence between scattered electrons and recoiling protons. Electrons without a high-energy proton in coincidence were assumed to be due to a neutron interaction. The impulse approximation as developed by Durand and McGee was used to extract from the data the ratio of neutron to proton cross sections. Neutron/proton cross section ratios from deuterium were measured at $q^2 = 7$, 10, 15, 20, 30, 45, and 70 f^{-2} (at 20°); at $q^2 = 15$ f^{-2} (at 90°); and at $q^2 = 115$ f^{-2} (at 29.64°). (Diss. Abstr.)

42532 AN EXPERIMENT TO MEASURE THE ELECTRIC FORM FACTOR OF THE PROTON. Dombey, N. (Daresbury Nuclear Physics Lab., Eng. Univ. of Sussex, Eng.). Phys. Lett., 29B: 588-9(Aug. 4, 1969).

An experiment is proposed to determine G_E. It requires the measurement of the spin correlation between initial and final proton states in elastic e-p scattering. (auth)

42533 PHOTOPRODUCTION SEARCH FOR DIPION RESONANCES IN THE MASS RANGE FROM 1360 TO 1780 MeV. Hicks, N.; Eisner, A.; Feldman, G.; Litt, L.; Lockeretz, W.; Pipkin, F. M.; Randolph, J. K.; Stanfield, K. C. (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2572. Phys. Lett., 29B: 602-4(Aug. 4, 1969).

A search was conducted for dipion resonances in the mass range 1360 to 1780 MeV photoproduced in the forward direction from a carbon target. No evidence for dipion resonances was found. (auth)

42534 PHOTOPRODUCTION OF ϕ MESONS FROM CARBON AT 1800 MeV. Mostek, Paul Joseph. Ithaca, N. Y., Cornell Univ., 1968. 89p.

Thesis.

The photoproduction of ϕ mesons from carbon was measured at a mean photon energy of 1800 MeV using a pair spectrometer to detect K^+K^- pairs in a mass region extending from 1006 to 1042 MeV. The experimental mass resolution has a FWHM of about 4 MeV. Pulse heights produced in three liquid Cherenkov counters were recorded for each event and analyzed to reject pions, electrons and protons. Spark chambers were used for reconstruction of trajectories. Approximately 165 ϕ's were observed yielding a cross section $d\sigma/dt = (0.75 \pm 0.17)$ $\mu b/GeV^2$/nucleon for $|t| = 0.175$ GeV^2. This value is consistent with a "vector dominance" prediction using ρ^0 photoproduction data, SU_3 coupling constants and a quark model prediction for the ρ-nucleon and ϕ-nucleon cross sections. (auth)

42535 EXPERIMENTAL DETERMINATION OF THE TRANSITION EFFECT IN ELECTROMAGNETIC CASCADE SHOWERS. Crannell, Carol Jo (Catholic Univ. of America, Washington, D. C.); Crannell, Hall; Gillespie, C. Richard; Pinkau, Klaus; Whitney, Randy R. Phys. Rev., 182: 1435-40(June 25, 1969).

The transition effect that occurs when an electromagnetic cascade crosses the boundary between different materials was measured. This transition effect is a rapid change in the numbers and spectra of electrons and photons which constitute the cascade, and in the resultant energy deposition. The magnitude of this effect depends on the age of the shower at the discontinuity in the critical energies. In the present experiment, 1-GeV cascade showers were developed in glass, iron, and lead, and 5-GeV showers in lead, each followed by a second medium of Plexiglas. The energy deposited as a function of position in the Plexiglas was measured for a variety of shower ages and for thicknesses of the transition region between 0 and 1 radiation length. The results show a smaller transition effect than predicted by Approximation B of the cascade theory developed by Rossi and Greisen, but the measured transition effect is sufficiently rapid to cause systematic errors on the order of 20% in cascade measurements in some cases. (auth)

Weak

Refer also to abstracts 41058 and 41067.

42536 EXPERIMENTAL SEARCH FOR SEMILEPTONIC NEUTRINO NEUTRAL CURRENTS. Camerini, U. (Univ. of Wisconsin, Madison); Ljung, D.; Sheaff, M.; Cline, D. Contract AT(11-1)-881. Phys. Rev. Lett., 23: 326-9(Aug. 11, 1969). (COO-881-243).

A search for the rare K^+ decay mode $K^+ \rightarrow \pi^+ \nu\bar{\nu}$ was carried out using K^+ mesons in a heavy-liquid bubble chamber. No events were found, and an upper limit on the branching ratio of this mode of 5×10^{-6} to all K^+ decays is obtained. Comparison is made with various theories which imply the existence of neutral neutrino currents. (auth)

42537 SINGLE PION PRODUCTION BY NEUTRINOS ON FREE PROTONS. Budagov, I.; Cundy, D. C.; Franzinetti, C.; (and others) (CERN, Geneva). Phys. Lett., 29B: 524-8 (July 21, 1969).

Using a propane bubble chamber the average cross section for single pion production by neutrinos on free protons was determined to be $(1.13 \pm 0.28) \times 10^{-38}$ cm^2 for neutrinos of energy between 1 and 4 GeV. The invariant mass distribution of the (πp) system indicates that N*(1236) production is the dominant process. Angular distributions of the pion in the (πp) rest frame are also presented. The results of the experiment are compared with theoretical predictions. (auth)

42538 AN UPPER LIMIT ON THE $K^0_S \rightarrow \mu^-\mu^+$ DECAY RATE. Hyams, B. D. (CERN, Geneva); Koch, W.; Potter, D. C.; Von Lindern, L.; Lorenz, E.; Luetjens, G.; Stierlin, U.; Weilhammer, P. Phys. Lett., 29B: 521-3(July 21, 1969).

From an experiment, studying μ pair and π pair production under similar experimental conditions in π-p collisions at 11 GeV/c beam momentum, an upper limit was derived for the decay mode $K^0_S \rightarrow \mu^-\mu^+$. The branching ratio $\Gamma(K^0_S \rightarrow \mu^-\mu^+)$ $\Gamma(K^0_S \rightarrow \text{all}) \leq 7.3 \times 10^{-6}$ was found at 90% confidence. (auth)

42539 BRANCHING RATIO AND POSSIBLE CP NONCONSERVATION IN RADIATIVE $K_{\pi 2}$ DECAY. Emmerson, J. McL.; Quirk, T. W. (Nuclear Physics Lab., Oxford). Phys. Rev. Lett., 23: 393-5(Aug. 18, 1969).

An upper limit of 1.90×10^{-4} was determined with 90% confidence for the branching ratio of the decay mode $K^+ \rightarrow \pi^+ + \pi^0 + \gamma$ in the range of $T_{\pi 2}$ from 55 to 80 MeV. The implications of this result for a possible CP nonconservation in radiative $K_{\pi 2}$ decay are discussed. (L.B.S.)

42540 TEST ON THE CONSERVATION OF THE MUONIC LEPTON NUMBER. Borer, K.; Hahn, B.; Kaspar, H.; Krienen, F.; Seiler, P.-G. (CERN, Bern. CERN, Fribourg, Switzerland). Phys. Lett., 29B: 614-17(Aug. 4, 1969).

An investigation was made on the conservation of the muonic lepton number by using a pure neutrino beam and by measuring the charge ratio of the muons in neutrino interactions. The experiment yields a new upper limit for a possible violation of the muonic lepton number of $<3.8 \times 10^{-3}$ (90% confidence) expressed in the μ^+ to μ^- ratio. (auth)

42541 EVALUATION OF BACKGROUND CONDITIONS FOR CONDUCTING UNDERGROUND EXPERIMENTS FOR THE DETECTION OF NEUTRINO DISPERSIONS ON ELECTRONS. Glotov, V. I.; Elpidinskii, A. V.; Zagrebin, V. A. Kosm. Luchi, No. 10, 92-4(1969). (In Russian).

An analysis of the intensity of the hard radiation from the ground and materials of a spark chamber (iron, transparent plastic) is made. The requirements concerning the value and kind of radioactive substances contaminating the equipment materials necessary for providing a sufficient excess of the effect over the background are considered. (auth)

42542 NATURAL BACKGROUND IN RADIOCHEMICAL NEUTRINO DETECTION EXPERIMENTS. Elpidinskii, A. V. Kosm. Luchi, No. 10, 78-80(1969). (In Russian).

The results are presented of a detailed evaluation of the background caused by the natural activity of the earth which will have place in the experiments of underground recording of solar neutrinos by the Pontecorvo method. It is shown that to reduce the background to 1% of the expected effect value, the specific activity of the material of the detector is to be less than 10^{-9} gU/g, and the concentration of the admixtures of S and Ca should be less than 10^{-3}%. (auth)

42543 MEASUREMENT OF THE DECAY PARAMETERS IN THE NONLEPTONIC DECAYS OF THE CHARGED SIGMA HYPERONS. Heintzelman, William Jacob. New Haven, Yale Univ., 1968. 139p.

Thesis.

The nonleptonic sigma decay modes $\Sigma^{\pm} \rightarrow n + \pi^{\pm}$ were studied using sigmas produced by the reactions $K^- + p \rightarrow \Sigma^{\pm} + \pi^{\mp}$ in the vicinity of the $Y_0^*(1520)$ resonance. The decay parameters α_-, α_+, φ_-, and φ_+ were measured, resulting in the values $\alpha_- = -0.133 \pm 0.034$ $\varphi_- = -14° \pm 26°$ $\alpha_+ = 0.063 + 0.046$ $\varphi_+ = 177° + 25°$. These results, together with the values of other previously measured parameters, confirm the predictions of the $|\Delta I| = 1/2$ rule applied to the nonleptonic charged sigma decay modes. The results are also in near agreement with current-algebra predictions that S_+ is equal to zero and are consistent with T-invariance. (Disser. Abstr.)

42544 PRECISION MEASUREMENT OF THE DECAY RATE OF ORTHOPOSITRONIUM. Beers, Richard Harry Jr. New Haven, Yale Univ., 1968. 155p.

Thesis.

Positronium, the electron-positron bound state, is an ideal system for tests of quantum electrodynamics and of the Bethe–Salpeter equation. The ground 1S state has two hyperfine levels: ${}^1S_0$ (parapositronium) and ${}^3S_1$ (orthopositronium). With the assumption of charge conjugation invariance in the electromagnetic interaction, the singlet state can be shown to annihilate only with the emission of an even number of photons (predominately two) and the triplet state only with the emission of an odd number (predominately three). The annihilation modes of this particle-antiparticle system are fundamental radiation processes whose characteristic decay rates can be calculated to a high degree of accuracy. The decay rate of orthopositronium has been calculated to the lowest contributing order of the fine structure constant α: $\gamma({}^3S_1)_{\text{theor}} = (4\alpha^6 mc^2/9h)(\pi^2 - 9) = 0.7210 \times 10^7$/sec. The best experimental value to date has been $\gamma({}^3S_1)_{exp} = (0.734 \pm 0.011) \times 10^7$/sec. The present experiment reports a value: $\gamma({}^3S_1)_{exp} = (0.7262 \pm 0.0015) \times 10^7$/sec which represents an increase in overall accuracy of a factor of 7 to 2 parts per thousand (1 standard deviation). Two other quantities determined in this experiment are the rates per psi at which orthopositronium is quenched in the two gases: Freon-12 and argon: $\gamma_f = (0.276 \pm 0.003) \times 10^5$/psi-sec and $\gamma_a = (0.178 \pm 0.006) \times 10^5$/psi-sec. (Disser. Abstr.)

42545 MEASUREMENTS OF THE BRANCHING RATIO AND FORM OF INTERACTION FOR THE BETA DECAY OF THE Λ HYPERON. Maloney, J. E.; Sechi-Zorn, B. (Univ. of Maryland, College Park). Phys. Rev. Lett., 23: 425-7(Aug. 25, 1969).

In a stopping-K^- exposure of the Brookhaven National Laboratory 30-in. hydrogen bubble chamber, 204 Λ β decays, $\Lambda \rightarrow p + e^- + \nu_e$, were found with a scanning efficiency of 0.97 ± 0.02. A branching ratio of $(0.80 \pm 0.08) \times 10^{-3}$ was obtained. Using SU(3) and conservation of vector current to determine the weak-magnetism to vector form-factor ratio in the baryon current, an axial-vector-to-vector ratio of $0.72^{+0.10}_{-0.14}$ is found. The results are in good agreement with Cabibbo theory and are insensitive to the relative strength of weak magnetism. (auth)

42546 MEASUREMENT OF THE BRANCHING RATIO $(K_L^0 \rightarrow \pi\mu\nu)/(K_L^0 \rightarrow \pi\nu)$. Evans, G. R. (Univ. of Edinburgh); Golden, M.; Muir, J.; Peach, K. J.; Budagov, I. A.; Hopkins, H. W. K.; Krenz, W.; Nezrick, F. A.; Worthington, R. G. Phys. Rev. Lett., 23: 427-30(Aug. 25, 1969).

The results of a study of K_L^0 decays observed in the CERN 1.1-m^3 heavy-liquid bubble chamber are presented. About 75,000 frames were scanned, and yielded some 7500 examples of isolated K_L^0 decays to charged particles. Based on a sample of 4000 events in a restricted fiducial region, the following branching ratios were found: $N(K_L^0 \rightarrow \pi^{\mp}\mu^{\pm}\nu)/N(K_L^0 \rightarrow \pi^{\pm}e^{\mp}\nu) = 0.648 \pm 0.030$, $N(K_L^0 \rightarrow \pi^+\pi^-\pi^0)/N(K_L^0 \rightarrow \text{all charged}) = 0.157 \pm 0.010$. (auth)

42547 K^+-MESON BRANCHING-RATIO MEASUREMENT. Zeller, M. E. (Univ. of California, Los Angeles); Haddock, R. P.; Helland, J. A.; Pahl, J.; Dairiki, N. T.; Beck, R. L.; Crowe, K. M.; Maung, M. T. Phys. Rev., 182: 1420-9(June 25, 1969).

A measurement of the rates $K^+ \rightarrow \pi^0 + \pi^+$, $K^+ \rightarrow \mu^+\pi^0\nu$, and $K^+ \rightarrow e^+ + \pi^0 + \nu$ with respect to $K^+ \rightarrow \mu + \nu$ has been made by using a magnetic spectrometer and spark chambers. Both the range and momentum of the charged decay product are measured and compared with a Monte Carlo calculation. The decay in flight of the K^+ mesons and the scattering of pions into the apparatus are rejected by a decay-time requirement. The results of the branching ratio measurement are $\Gamma(K_{\mu2}) = (65.0 \pm 0.9)$%, $\Gamma(K_{\pi2}) = (19.8 \pm 1.1)$%, $\Gamma(K_{\mu3}) = (3.5 \pm 0.6)$%, and $\Gamma(K_{e3}) = (4.4 \pm 0.4)$%, on the assumptions $\Gamma(\tau) = (5.57 \pm 0.03)$% and $\Gamma(\tau') = (1.71 \pm 0.07)$%. (auth)

Strong (Baryon-Induced)

42548 (PURC-2137-9) $n + p \rightarrow d + \pi^0$: A TEST OF CHARGE INDEPENDENCE FROM THRESHOLD THROUGH RESONANCE PEAK. Technical Report No. 4. Hammerman, Ira Saul (Princeton Univ., N. J. Elementary Particles Lab.). June 30, 1969. Contracts AT(30-1)-2137; N00014-67-A-0151-001. 163p. Dep. CFSTI.

The differential cross sections for the reaction $n + p \rightarrow d + \pi^0$ are found in ten energy bins from threshold to $T_n = 680$ MeV with an accuracy greater than that of previous experiments. Also the angular distributions and the shape of the total cross section from threshold up and over the peak to $T_n = 720$ MeV are studied. Spark chambers, scintillation counters and a spectrometer magnet were used for the study. (J.F.P.)

42549 POLE-EXTRAPOLATION RESULTS FROM $pp \rightarrow \Delta^{++}n$ AT 6.6 GeV/c. Ma, Z. Ming (Michigan State Univ., East Lansing); Smith, Gerald A.; Sprafka, R. J.; Colton, Eugene; Schlein, Peter E. Phys. Rev. Lett., 23: 342-6(Aug. 11, 1969).

An experimental study is presented of the low-momentum-transfer $\Delta^{++}n$ component of 6424 $pp \rightarrow p\pi^+n$ events at 6.6 GeV/c. The π^+p elastic cross sections in the Δ^{++} region are measured by means of several different pole-extrapolation procedures. It was found that the conventional Chew–Low extrapolation procedure yields results not in satisfactory agreement with the known on-shell cross sections. A modified extrapolation procedure is suggested which yields results in good agreement with the on-shell values. (auth)

42550 STUDY OF HYPERON–NUCLEON INTERACTION IN THE REACTION $K^-d \rightarrow \pi^-p\Lambda$ AT REST. Tan, Tai Ho (Stanford Univ., Calif.). Phys. Rev. Lett., 23: 395-8(Aug. 18, 1969).

A Λp system with high statistics and mass resolution was studied in detail. The broad bump in the low-mass region can be attributed to contribution from both the impulse and final-state-interaction mechanisms. The low-energy Λp scattering parameters are deduced to be $a_0 = -2.0 \pm 0.5$ and $r_0 = 3.0 \pm 1.0$ F. The higher mass spectrum can be fitted to two Breit–Wigner resonant structures with $M_1 = 2128.7 \pm 0.2$, $\Gamma_1 = 7.0 \pm 0.6$, and $M_2 = 2138.8 \pm 0.7$, $\Gamma_2 = 9.1 \pm 2.4$ MeV. Attempts were carried out to understand these peaks via a ΣN final-state-interaction model. (auth)

42551 SYSTEMS OF ANTIPROTONS AND PROTONS STUDIES WITH THE AID OF LIQUID HYDROGEN BUBBLE CHAMBERS. Astier, Andre (College de France, Paris). Ind. At., 13: No. 5-6, 47-55(1969). (In French).

The interest of the study of antiproton-proton systems lies in the fact that the final state of annihilations contains only mesons (pions and kaons). In his way it is possible to study the interaction of these mesons two by two, or three by three, etc. The "two-by-two" interactions have parameters which can be found by dephasing. Interesting results have been obtained in connection with these dephasings. The study has primarily supplied valuable information about the known resonances and has elicited new mesonic resonances (E^*, C, D^*, F_1). (auth)

42552 SEARCH FOR A FLUCTUATING ANISOTROPY IN THE n–p SCATTERING PROCESS AT A FEW MeV NEUTRON

ENERGIES. Paulsen, A.; Liskien, H. (EURATOM, Geel, Belg.). Phys. Lett., 29B: 562-3(Aug. 4, 1969).

In contradiction to a recent publication no fluctuations in the n-p differential scattering cross section for proton forward scattering could be detected within the experimental uncertainties of ±3%. (auth)

42553 ANTIPROTON–PROTON ELASTIC SCATTERING AT 3.55 GeV/c. Baker, W. F. (CERN, Geneva); Carlson, P. J.; Chabaud, V.; Lundby, A.; Banaigs, J.; Berger, J.; Bonnel, C.; Duflo, J.; Goldzahl, L.; Plouin, F. Nucl. Phys., B12: 5-8(1969).

Antiproton-proton elastic scattering was measured at 3.55 GeV/c in the c.m. angular range from 20° to 77° and from 109° to 160°. Forward $\bar{p}p$ elastic scattering shows a structure near $t = -0.5$ $(GeV/c)^2$. In the backward region two events are observed. (auth)

42554 ANALYSIS OF CENTRAL NUCLEUS–NUCLEUS COLLISIONS AT THE ENERGY EXCEEDING 1 TeV/NUCLEON. Rybicki, K. (Inst. for Nuclear Research, Krakow). Acta Phys. Pol., 36: 69-81(July 1969).

The central collisions of cosmic-ray nuclei with nuclei of photographic emulsion are considered. On the basis of 36 interactions of energy per nucleon exceeding 0.1 TeV it was found that events with $N_h < 5$ and $N_h > 10$ (no intermediate N_h-values were observed, corresponding to collisions with light (H, C, N, O) and heavy (Ag, Br) emulsion nuclei, respectively. It was also found that the Castagnoli formula is a reliable energy estimate for central nucleus-nucleus collisions at the energy higher than 0.1 TeV/nucleon. There were 13 central nucleus-nucleus collisions of energy per nucleon exceeding 1 TeV measured. It was found that in collisions with light target nuclei the quantity $\langle n_s - Z/A \rangle = 6.0 \pm 0.9$ and only a fraction of incident nucleons interacts, while in collisions with heavy target nuclei $\langle n_s - Z/A \rangle = 19.2 \pm 8.4$ and practically all incident nucleons interact. Among highest-energy secondaries the neutral-to-charged ratio is 15 : 14 which means that nucleons are leading particles. These nucleons carry away on the average (50 ÷ 60)% of primary energy. There is an indication that their transverse momenta exceed 0.4 GeV/c especially in collisions with light target nuclei. The characteristics of angular distribution of secondary particles are similar to those in nucleon-induced jets. In general the central nucleus-nucleon collisions are well described by the superposition of nucleon-nucleon collisions. (auth)

42555 PRODUCTION OF ANTINEUTRONS FROM THE INTERACTIONS OF ANTIPROTONS OF 5 GeV/c IN NUCLEAR EMULSIONS. Hebert, J. (Univ. of Ottawa); Kamal, A. A.; Raghavan, Indira; Padmavathi, S. V.; Santhalaxmi, A. Phys. Rev., 182: 1430-4(June 25, 1969).

Suitable criteria are applied to select annihilation stars of antineutrons produced in the interactions of 5-GeV/c antiprotons with emulsion nuclei. The shower multiplicity, heavy-prong number, and angular distribution of shower tracks in these stars are found to be similar to those caused by the reemerging antiprotons. The spatial distribution of neutral stars along the beam axis is found to have the expected behavior. The problem of background is discussed in detail, and the various characteristics of neutral stars in question are shown to be consistent with the interpretation of their origin. The production frequency of antineutrons from the emulsion nuclei is deduced; the charge-exchange cross section, averaged over protons and neutrons, is estimated and compared with the value obtained from the hydrogen-bubble-chamber experiment at comparable energy. (auth)

42556 $\bar{p}-p$ ANNIHILATION INTO BOSON PAIRS AT 6 AND 8 GeV/c. Birnbaum, D. (Carnegie-Mellon Univ., Pittsburgh); Edelstein, R. M.; Hien, N. C.; (and others). Phys. Rev. Lett., 23: 433-6(Aug. 25, 1969).

The reaction $\bar{p} + p \rightarrow \pi^{\mp} + B^{\pm}$ with small momentum transfer to the pion was studied at 6 and 8 GeV/c. For $B^+ \equiv \pi^+$ the average differential cross sections $d\sigma/dt$ are $4.6 \pm 1.9\ \mu b/(GeV/c)^2$ for $-0.08\ (GeV/c)^2 > t > -0.16\ (GeV/c)^2$ at 6 GeV/c, and $1.5 \pm 0.6\ \mu b/(GeV/c)^2$ for $-0.07\ (GeV/c)^2 > t > -0.45\ (GeV/c)^2$ at 8 GeV/c. At 8 GeV/c the cross sections are $0.56 \pm 0.33\ \mu b/(GeV/c)^2$ for $B^- \equiv \pi^-$ and $1.9 \pm 1.1\ \mu b/(GeV/c)^2$ for $B^- \equiv \rho^-$ averaged over the momentum-transfer interval $-0.05\ (GeV/c)^2 > t > -0.46\ (GeV/c)^2$. (auth)

Strong (Meson-Induced)

Refer also to abstracts 42538 and 42684.

42557 (COO-1195-163) THE REACTION $K^+p \rightarrow K^+p\pi^+\pi^-$ AT 3.2 GeV/c. Technical Report 177. Eisenstein, L. (Illinois Univ., Urbana. Dept. of Physics). Mar. 1969. Contract AT(11-1)-1195. 158p. Dep. CFSTI.

Thesis. Submitted to Harvard Univ., Cambridge.

The reaction $K^+p \rightarrow K^+p\pi^+\pi^-$ is investigated at an incident beam momentum of 3.2 GeV/c using the Argonne 30″ hydrogen bubble chamber. The cross section for this reaction is found to be 2.2 ± 0.2 mb. Copious production of $K^*(890)$ and $N^{*++}(1236)$ is observed. The cross section for the double resonance channel, $K^{*\circ}(890)$ $N^{*++}(1236)$, is determined to be 0.97 ± 0.1 mb. We compare the production and decay angular distributions of this final state with predictions of various dynamical models and find that no one model completely accounts for all the features of the data. A low mass enhancement in the $K^{*\circ}(890)\pi^+$ system is observed. It is found that kinematic effects cannot completely account for the observed enhancement. A moment analysis of the decay angular distributions indicates that the most likely spin-parity assignment for this enhancement is 1^+. (auth)

42558 (JINR-P2-4520) ENERGY DEPENDENCE OF THE INTERACTION CROSS SECTIONS OF π-MESONS WITH THE ATOMIC NUCLEI AT ENERGIES MORE THAN 50 MeV. Barashenkov, V. S.; Gudima, K. K.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 19p. (In Russian). Dep.

The curves of the energy dependence of the integrated cross sections σ_{tot}, σ_{in}, σ_{el} for the interaction of π-mesons with He, Be, C, Al, Ti, Fe, Cu, Gd, Pb, U are given. (auth)

42559 (UCRL–18894) THE $\omega\rho^0$ INTERFERENCE EFFECT. Goldhaber, G.; Butler, W. R.; Coyne, D. G.; Hall, B. H.; MacNaughton, J. N.; Trilling, G. H. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 21p. (CONF-690521–4; CONF-690608–7). Dep. CFSTI.

From Conference on the π-π and K-π Interactions, Argonne, Ill.

From International Conference on Elementary Particles, Lund, Sweden.

A phenomenon interpreted as the $\omega\rho$ interference effect which occurs as destructive interference in the reactions $\pi^+ + p \rightarrow \pi^+ + \pi^- + \pi^+ + p$ and $\pi^+ + p \rightarrow 2\pi^+ + \pi^- + \pi^0 + p$ from a separated meson (π^+) beam interacting in a bubble chamber. The momenta varied between 3.7 and 4.0 GeV/c. The channels $\pi^+ + p \rightarrow \pi^+ + \pi^- + \Delta^{2+}$ and $\pi^+ + p \rightarrow \pi^+ + \pi^- + \pi^0 + \Delta^{2+}$ were studied for ω^0 and ρ^0 production. The observed phenomenon is a four standard deviation valley in the $M(\pi^+\pi^-)$ distribution centered at the ω^0 mass. Also a significant change is observed in the decay angular distribution and the asymmetry of the ρ when passing through $m_{\pi\pi} = m_\omega$. These phenomena appear collectively as dips in the moments $N(Y_2^0)$ and $N(Y_1^0)$. An estimate of the branching ratio $(\omega \rightarrow 2\pi/\omega \rightarrow 3\pi)$ is obtained as an effect of the $\omega-\rho$ interference. (J.F.P.)

42560 (UR-875-282) π-π SCATTERING IN THE I = 2 CHANNEL. Katz, W. M.; Ferbel, T.; Slattery, P. F.; Yuta, H. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). July 16, 1969. Contract AT(30-1)-875. 8p. (CONF-690521-5). Dep. CFSTI.

From Conference on the $\pi-\pi$ and K$-\pi$ Interactions, Argonne, Ill.

Preliminary measurements of the s-wave and d-wave I = 2 $\pi\pi$ scattering phase shifts are obtained. The I = 2 s-wave phase shift at the mass of the K^* is $-8.7 \pm 0.9°$. (auth)

42561 $\pi^0\pi^0$ MASS SPECTRUM AND δ_0^0 BELOW 1 GeV. Smith, Gerald A. (Michigan State Univ., East Lansing); Manning, Robert J. Phys. Rev. Lett., 23: 335-8(Aug. 11, 1969).

The δ_0^0 phase shifts were measured from $\pi^+\pi^-$ elastic scattering and the four possible solutions were compared with the $\pi^0\pi^0$ mass spectrum. Only one solution, characterized by a very gradual increase of the phase shifts to 90°, compares favorably. (auth)

42562 $\pi-\pi$ PHASE SHIFTS IN THE REGION 1.0 TO 1.4 GeV/c^2. Oh, B. Y. (Univ. of Wisconsin, Madison); Walker, W. D.; Carroll, J. T.; Firebaugh, M.; Garfinkel, A.; Morse, R.; Prentice, J. D.; Steenberg, N. R.; West, E. Contract AT(11-1)-881. Phys. Rev. Lett., 23: 331-5(Aug. 11, 1969). (COO-881-211).

$\pi\pi$ scattering in the di-pion mass region 1.0–1.4 GeV is analyzed. It is shown that an anomaly of the $\pi^-\pi^+$ state in the region 1.0–1.2 GeV is either an I = 0 D-wave amplitude which interferes with a nearly static I = 1 P-wave amplitude or a Breit–Wigner D wave which interferes with a moving P wave (possibly resonant). The f^0 meson seems to show considerable inelasticity. (auth)

42563 SEARCH FOR THE NEUTRAL DECAYS $\omega^0 \rightarrow \eta\gamma$ AND $\omega^0 \rightarrow \pi^0\pi^0\gamma$. Strugalskii, Z. S. (Inst. of Nuclear Research, Warsaw); Chuvilo, I. V.; Ivanovskaya, I. A.; Jablonski, Z.; Kanarek, T.; Okhrimenko, L. S.; Fenyves, E.; Gemesy, T.; Krasnovsky, S.; Pinter, G. Phys. Lett., 29B: 532-4(July 21, 1969).

The decays of $\omega^0 \rightarrow \eta\gamma$ and $\omega^0 \rightarrow \pi^0\pi^0\gamma$ are investigated by means of the effective mass method. Decay branching ratios of $\omega^0 \rightarrow \eta\gamma$ and $\omega^0 \rightarrow \pi^0\pi^0\gamma$ are determined. (auth)

42564 INVESTIGATION OF THE $M(\pi^0\pi^0)$ EFFECTIVE MASS SPECTRUM. Strugalskii, Z. S. (Inst. of Nuclear Research, Warsaw); Chuvilo, I. V.; Ivanovskaya, I. A.; Jablonski, Z.; Kanarek, T.; Okhrimenko, L. S.; Fenyves, E.; Gemesy, T.; Krasnovsky, S.; Pinter, G. Phys. Lett., 29B: 518-20(July 21, 1969).

Investigation of the effective mass spectrum of the π^0-π^0 system is carried out in the interval of mass values $M(\pi^0\pi^0) \leq 1.3$ GeV. A peak is observed at $\overline{M}(\pi^0\pi^0) = 730 \pm 15$ MeV. (auth)

42565 OBSERVATION OF D^0 MESON IN REACTION $\pi^+p \rightarrow p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ AT 8 GeV/c. Otwinowski, S. (Inst. of Nuclear Research, Warsaw). Phys. Lett., 29B: 529-31(July 21, 1969).

Production of the D^0 meson and its decay into $\eta\pi^+\pi^-$ is observed in the reaction $\pi^+p \rightarrow p\pi^+\pi^+\pi^+\pi^-\pi^-\pi^0$ at 8 GeV/c. Indications for the decay mode $D^0 \rightarrow \delta^{\pm}\pi^{\mp} \rightarrow \eta\pi^+\pi^-$ are presented. The cross section for the two-body reaction $\pi^+p \rightarrow N^{*++}(1236)\ D^0$ is estimated. (auth)

42566 SINGLE PION PRODUCTION IN THE K^+P CHANNEL FROM 860 TO 1370 MeV/c. Bland, Roger Woodward. Berkeley, Calif., Univ. of California, 1968. 156p.

Thesis.

Single pion production by K^+ mesons on protons from 860 to 1360 MeV/c incident beam momentum was studied. Strong $N^*(1236)$ production in this region was found, with its maximum cross section occurring slightly below the 1250 MeV/c peak in the total cross section reported by Cool et al. A partial wave analysis of the KN^* final state indicates that the N^* production is dominated by the $P_{1/2}$ and $P_{3/2}$ states in the region of the Cool peak, with no evident phase variation from 860 to 1360 MeV/c. The N^* production is qualitatively consistent with the predictions of the magnetic dipole (M1) ρ-exchange model; near threshold, however, the experimental cross section is too high by a factor of 5 and the detailed partial wave structure deviates considerably from the M1 predictions. The smooth variation with beam momentum of all properties of the K^+p system suggests that the K^+p channel has no strong resonant activity, and should be interpreted in terms of t-channel phenomena. (Diss. Abstr.)

42567 A STUDY OF SIX-PRONG EVENTS PRODUCED IN π^-p INTERACTIONS AT 6 GeV/c. Suen, King Foo. Bloomington, Ind., Indiana Univ., 1968. 88p.

Thesis.

The experiment was performed at the Argonne National Laboratory with the momentum of the incident negative pion at $5.97 \pm .05$ GeV/c. Approximately 96,000 pictures were taken with the MURA 30 inch hydrogen bubble chamber. The six prong events selected for investigations were required to have at least 7 inches of track for every track diverging from the production vertex to ensure good momentum determination. Event selection was based on the ionization remark given by the scanner, missing energy and missing momentum. All the events were classified into five channels, and only channel 1: $\pi^-p \rightarrow 3\pi^-2\pi^+p$ and channel 2: $\pi^-p \rightarrow 3\pi^-2\pi^+p\pi^0$ were investigated in more detail. The cross section for different channels were also calculated and compared with the data from other experiments at different energies. They were consistent. Known resonances are observed in 25–50% of the events in channel 1 and channel 2. $N^{*++}(1236)$ and ρ^0 are observed in the first channel (93 ± 29 and 115 ± 27 events respectively). The second channel is dominated by ω^0 production (144 ± 29 events). Strong correlation of $N^{*++}(1236)$ and ρ^0; and $N^{*++}(1236)$ and ω^0 in these two channels respectively are observed (both correlations amount to approximately 70 events). There are considerable numbers of A_1^- in the first reaction and B^-, $(\omega^0\pi^+)$ at 1380 MeV, and $N^*(1688)$ in the second reaction. A strange feature appeared in the effective mass distribution of $(\pi^+\pi^-)$ at 550 MeV. The center of mass angular distributions of each particle in channel 1 and channel 2 were histogrammed. The differences in behavior of the center of mass angular distributions of like and unlike pion pairs, predicted by Bose-Einstein statistics, is illustrated. The anisotropy of the nucleon indicates the percentages of central-collision and peripheral-collision interactions. The search for quasi-two-body final states in N^{*++}, ζ^0 correlated events and N^{*++}, ω^0 correlated events does not support the fraction of peripheralism implied by the anisotropy consideration. The transverse momentum was also investigated to check the validity of Hagedorn's distribution in his Fire-ball model. (TSS) (Diss. Abstr.)

42568 A STUDY OF FINAL STATES WITH A $K\overline{K}$ PAIR PRODUCED BY 6.0 BeV/c NEGATIVE PI MESONS IN HYDROGEN. Potocki, Kenneth Anthony. Bloomington, Ind., Indiana Univ., 1968. 166p.

Thesis.

The analysis of $K\overline{K}$-pair final states in a π^-p bubble chamber experiment performed at the Argonne National Laboratory Zero Gradient Synchrotron is discussed. The data collection and their systematic reduction to produce the $K\overline{K}$ sample are described. Event selection criteria are established to separate the various reactions. The $K\overline{K}$ cross section is found to be 1.71 ± 0.28 mb at this energy. The total strange-particle cross section is estimated to be 2.95 ± 0.30 mb. This indicates that reactions involving strange particles account for about 10% of the total π^-p cross section at this energy. By comparison, this relative abundance of strange particles is found to be increasing with energy. Reaction cross sections are presented and found to be decreasing for three-body final states, cresting for four-body final states, and rising for five-body final states. Cross sections for semi-two-body final states of the form $\pi^-p \rightarrow Y^*K^*$ are consistent with zero. The most prominently produced resonance in these data is $K^*(890)$, appearing in almost all the final states in which it could be formed. There is some indication of $Y_1^*(1770)$ decaying into $\overline{K}N$. Several interesting nonstrange mesons are seen involving $K\overline{K}$ pairs. The $K_1^0K_1^0$ threshold enhancement is observed, the data being consistent with a resonance interpretation, $S^*(1068)$; however, a simple s-wave scattering length interpretation could not be excluded. There is some indication of the $K^*\overline{K} + \overline{K}^*K$ decay mode for three of the poorly established resonances in the 1.6 to 1.8 BeV mass region: $\pi_A(1640)$, $\rho(1715)$ and $\eta_A(1830)$. Unfortunately the data are too sparse to allow these objects to be disentangled. A study of the center-of-mass angular distributions for the nucleon in three- to six-body final states indicated that, while the peripheral interaction could account for the production of $K\overline{K}$ pairs alone, collisions with large momentum transfer are necessary for pion emission in addition to strange-particle production. (Disser. Abstr.)

42569 A SYSTEMATIC SEARCH FOR STRANGE PARTICLE DECAYS OF N^*'S AND Δ'S IN π-p INTERACTIONS AT 5.0 GeV/c. Weisbach, Paul Jerome. Lafayette, Ind., Purdue Univ., 1968. 156p.

Thesis.

A study of strange particle production in π-p interactions at 5.0 GeV/c incident pion momentum is presented. Particular emphasis is placed on the search for nonstrange nucleon resonances with strange particle decays. Cross sections are given for the observed decays. Cross sections are given for the observed final states. Multi-body final states are examined for resonance production. Cross sections for the more prominent resonances are determined. The study of $S = 0$, $B = 1$ systems reveals enhancements in the ΛK and ΣK spectra of the three-body $YK\pi$ states near threshold and in the $\Sigma K\pi$ spectra of the $\Sigma K\pi\pi\pi$ states. Resonance interpretations of these enhancements are discussed. (Diss. Abstr.)

42570 STUDY OF $Y_1^*(1660)$ AND $Y_1^*(1700)$ IN K^-p INTERACTIONS AT 4.6 BeV/c AND 5.0 BeV/c. Primer, Milton Chester. Syracuse, N. Y., Syracuse Univ., 1968. 124p.

Thesis.

The data obtained for this experiment was part of an extensive study of K^-p interactions at 4.6 BeV/c and 5.0 BeV/c, conducted by groups from Syracuse University and Brookhaven National Laboratory. Approximately 300,000 pictures were taken in several exposures of the 80 inch BNL liquid hydrogen bubble chamber to a separated K^- beam at the Brookhaven AGS. Significant $Y_1^*(1660)^+$ production was observed at these energies primarily in the $\Sigma^0\pi^+$ and $(\Sigma\pi\pi)^+$ states. A detailed analysis yielded values for the branching fractions of the $Y_1^*(1660)^+$. No conclusions could be made from a study of the effective mass distributions concerning the possible $Y_1^*(1660)$ decay modes. Previous determinations of the branching fractions of the $Y_1^*(1660)$ are reviewed; a compilation and discussion of these results is presented. Evidence was found in a study of the reaction channel $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$ which strongly supports the existence of a new Y_1^* resonance at ~1700 MeV/c^2 in the $\Lambda\pi^+$ system as first reported by M. Derrick et al., and later by D. C. Colley et al. There were no unambiguous indications of other decay modes of the new resonance. A compilation of high energy experiments yields values for the mass and width of $M = 1701 \pm 9\ \text{MeV}/c^2 - \Gamma = 110 \pm 19\ \text{MeV}/c^2$. No useful information was obtained concerning the spin and parity quantum numbers of the $Y_1^*(1700)$. The $\Lambda\pi^+$ partial cross section of the $Y_1^*(1700)$ was found to be $19 \pm 5\ \mu b$ at this energy. The $Y_1^*(1660) \rightarrow \Sigma\pi$ partial width of 40 ± 19 MeV was used as partial input to test the SU(3) decay rate predictions for a proposed $3/2^-$ baryon octet composed of the $N^*(1525)$, $Y_0^*(1690)$, $Y_1^*(1660)$, $\Xi_{1/2}^*(1815)$. With mixing allowed between the $Y_0^*(1690)$ and the unitary singlet $Y_0^*(1518)$, good agreement was found for all decay rates except the $\Sigma\overline{K}$ partial width of the $\Xi^*(1815)$. (Diss. Abstr.)

42571 FURTHER EVIDENCE FOR $N^*\frac{1}{2}$ NUCLEON RESONANCES IN THE MASS RANGE 1800 TO 2200 MeV. Lea, A. T. (Rutherford Lab., Chilton, Eng.); Oades, G. C.; Ward, D. L.; Cowan, I. M.; Gibson, W. M.; Gilmore, R. S.; Malos, J.; Smith, V. J.; Kemp, M. A. R. Phys. Lett., 29B: 584-7(Aug. 4, 1969).

A constrained phase shift analysis of new π^-p elastic scattering data is compared with the CERN πN phases in the range 1.0 to 2.0 GeV. (auth)

42572 K^+p ELASTIC SCATTERING AT 864, 969, AND 1207 MeV/c. Bland, R. W.; Goldhaber, G.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Lett., 29B: 618-20(Aug. 4, 1969).

The differential cross section for K^+p elastic scattering was measured at 864, 969, and 1207 MeV/c. The data show a smooth transition from low-energy s-wave scattering to high-energy diffraction, and are somewhat in disagreement with a recent experiment on K^+p backward scattering. (auth)

42573 OBSERVATION OF FORWARD PEAKS IN SINGLE-MESON- EXCHANGE FORBIDDEN REACTIONS. Dauber, P. M. (Univ. of California, Berkeley); Hoch, P.; Manning, R. J.; Siegel, D. M.; Abolins, M. A.; Smith, G. A. Phys. Lett., 29B: 609-13 (Aug. 4, 1969).

Forward peaks of 2 to 150 μb/sr were observed in the differential cross section in Δ(1236), Y*(1385) and Ξ*(1530) production reactions which can proceed by single-meson exchange only if $I \geq 3/2$ or $|S| = 2$ mesons exist. The data are in the beam momentum range from 1.8 to 4.2 GeV/c. Interpretations involving interference among s-channel resonances or two-meson exchange are not ruled out. (auth)

42574 THE BINDING ENERGY VALUES OF THE Λ^7Be, Λ^{10}B, AND Λ^{11}B HYPERNUCLEI. Bohm, G. (Deutsche Akademie der Wissenschaften zu Berlin); Klabuhn, J.; Krecker, U.; (and others). Nucl. Phys., B12: 1-4(1969).

Further examples of the π^- mesonic decay of Λ^7Be, Λ^{10}B, and Λ^{11}B hypernuclei are reported. The binding energy values obtained in this work are combined with previous results. (auth)

42575 COMPARISON OF K*(890) PRODUCTION IN K^-n AND K^-p INTERACTIONS NEAR 4.5 GeV/c. Carmony, D. D. (Purdue Univ., Lafayette, Ind.); Clopp, H. W.; Garfinkel, A. F.; Gutay, L. J.; Miller, D. H.; Eisner, R. L. Nucl. Phys., B12: 9-14(1969).

The production and decay angular distributions of the K*(890) in K^-n and K^-p interactions at 4.5 GeV/c are compared. A study was made of 377 K*(890) events in the former and 743 in the latter, corresponding to cross sections of 224 ± 20 μb and 250 ± 20 μb respectively. The data are compared with absorption and Regge-pole models. (auth)

42576 STRUCTURE IN THE $\pi^+\pi^-$ SYSTEM AT 480 MeV. Dubal, Leo (Univ., Geneva. CERN, Geneva); Roos, Matts. Nucl. Phys., B12: 146-54(1969).

A 25 μb enhancement (4-5 standard deviations) in a compiled $\pi^+\pi^-$ mass distribution from $\pi^-p \to \pi^+\pi^-n$ is studied. Failing to explain it as an effect of misidentification (accidental kinematic misfits) it is proposed that it is due to an $I = 0$ resonance, decaying strongly or electromagnetically. For the strong decay a particular model is studied which fits the mass distribution well. The mass of the resonance is 482 ± 3 MeV and the width $\lesssim$25 MeV. In the particular strong decay model the width is 9 MeV. Experimental arguments render the electromagnetic decay less likely. (auth)

42577 ELASTIC SCATTERING OF 2.0 GeV/c NEGATIVE PIONS OFF PROTONS. Tuli, S. K. (Banaras Hindu Univ., India). Nucl. Phys., B12: 79-88(1969).

An experimental study of the elastic scattering of negative pions off protons at 2.0 GeV/c is presented. The differential cross section is fitted to a polynomial in $\cos\theta_{cm}$ and the forward angular region as a diffraction peak. The results are compared with those from other bubble chamber experiments at neighboring energies and discussed in terms of optical model and possible exchange trajectories. (auth)

42578 K^-d INTERACTIONS WITH NON-STRANGE MESON EXCHANGE AT 3 GeV/c. de Wit, Simon Alle. Amsterdam, Univ. of Amsterdam, 1968. 67p.
Thesis.

A study of the interactions between mesons (K^-) and deuterons at 3 GeV/c in a deuterium bubble chamber is made. The reactions studied have the common feature that the proton and neutron appear again in the final state in a bound state or otherwise. (J.F.P.)

42579 PROPERTIES OF THE K*(1420) MESON. Goz, Barton. Syracuse, N. Y., Syracuse Univ., 1968. 74p.
Thesis.

An exposure of K^-p interactions at 4.6 and 5.0 BeV/c beam momentum obtained at the Brookhaven National Laboratory 80″ hydrogen bubble chamber was studied by groups at Syracuse University and B. N. L. This analysis yielded a clear K*(1420) signal in several final states. A measurement of the K*(1420) spin-parity is obtained by comparing the observed production and decay angular distributions with those predicted by a model of (1420) production via one particle exchange with ω dominance. The comparison indicates that $J^P = 2^+$ is strongly favored over 1^- and 3^-. In addition the data allow for the determination of several (1420) branching ratios. These measurements together with other known 2^+ meson branching ratios are compared with the predictions of unbroken SU(3). The theory is found to be consistent with presently available data. (Disser. Abstr.)

42580 STUDY OF THE REACTION $\pi^- + p \to 2\pi^- + 2\pi^+ + n + m\,\pi^0$ AT 4 GEV/c MOMENTUM OF THE π^- MESONS. Azimov, S. A.; Grishin, V. G.; Gulyamov, K. G.; Muminov, M. M.; Trka, E.; Yuldashev, B. S. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 10, 17–19(1968). (In Russian).

A total of 122 of the above events was detected on 126,000 stereoframes which were obtained by means of a 24-liter, propane bubble chamber. The efficiency of double examination for an event of a given type was equal to 88 ± 2%. A single event corresponded to a cross section of 0.49 ± 0.04 microbarns. The efficiency of π^0-meson counting was 0.44%. The interactions of π^- mesons with carbon nuclei were eliminated by using the mass deficiency distribution. It is shown that in most cases a total of two π^0 mesons are formed with a cross section of $\sigma(2\pi^0) = 1.1 \pm 0.15$ millibarns. No other sources for the generation of gamma quanta besides π^0-mesons were found. The total effective cross section for the generation of boson resonances did not exceed 0.4 millibarns. The problem of the existence of nucleon isobars could not be resolved. (TTT)

Particle Interactions and Properties (Theoretical)

42581 EXACT ANALYTICAL SOLUTION AND NUMERICAL TREATMENT OF THE MILNE PROBLEM WITH ABSORPTION AND ANISOTROPIC SCATTERING. Vanmassenhove, F. R. (Rijksuniversiteit, Ghent). Physica, 42: 179-204(Apr. 21, 1969).

The rigorous mathematical treatment of the Milne problem, with absorption, in the case of an arbitrary anisotropic scattering law and constant velocity is presented. The exact expression for the angular distribution of the emerging particles is obtained, as well as the expressions for the angular density in the source-free half-space. By extending the medium to an infinite one, it is shown that the angular density in the homogeneous medium is a function of the distribution in the boundary plane. Furthermore, the emerging angular distribution satisfies a homogeneous integral equation, which is then solved by the Wiener–Hopf technique. A number of coefficients have to be determined numerically but the procedure is simple and straightforward. The formalism is illustrated by a numerical example, in which the angular density in the boundary plane and the scalar density in the semi-infinite medium are calculated. (auth)

General

Refer also to abstracts 42700, 42733, 42756, and 42981.

42582 PARTICLE ASPECTS OF PHONONS. Jensen, H. Hoejgaard; Nielsen, P. Hedebol. Kgl. Dan. Vidensk. Selesk., Mat.-Fys. Medd., 37: 1-28(1969).

The possibility of introducing dynamical variables for a single phonon is investigated. A space time description of localized phonons leads to position and direction variables. Lattice translations, point group transformations and local rotations are used to define variables analogous to momentum, angular momentum, parity and spin of an ordinary particle. (auth)

42583 CURRENT ALGEBRA AND DISPERSION RELATIONS. Dahmen, Hans D.; Rothe, Klaus D. (Univ., Heidelberg). Nucl. Phys., B12: 187-96(1969).

An extension of the soft pion results to arbitrary points on the light cone is obtained. As an illustration of the procedure two particular matrix elements of the equal time commutators of charge densities are studied, which are rewritten in the form of a Low representation. Under some extra but weak assumptions the desired generalization is then obtained. (auth)

42584 FORMULA FOR THE SHADOW ELASTIC SCATTERING IN MULTI REGGE EXCHANGE MODEL. Turnau, J. (Jagellonian Univ., Krakow). Acta Phys. Pol., 36: 7-10(July 1969).

A formula for the overlap function in the multi-Regge-exchange model is derived. The formula expresses the overlap function as an average of a quantity depending on the momenta of the final particles. (auth)

42585 INFORMATION THEORY AND MULTIPARTICLE PRODUCTION. Rotelli, P. (Imperial Coll. of Science and Tech., London). Phys. Rev., 182: 1622-7(June 25, 1969).

The secondary particles produced in high-energy inelastic collisions are treated statistically but in a manner distinct from the concept of one or more fireballs. The classical grand-canonical approach is employed, and in the spirit of information theory an entropy is defined for the system. It is postulated that this entropy is independent of the energy of the system for a sufficiently high incoming energy. Consequently, the energy dependence of the charged multiplicity N of the secondaries is determined to be $N \sim (E_0/\mu)^{1/2}$, where E_0 is the incoming center-of-mass energy and μ a normalizing mass. Under additional but natural assumptions, the ratios $N_\pi \pm N_K \pm N_{p\bar{p}}$ are predicted. Comparison of our results is made with experiment, and some limitations and consequences of the method are discussed. (auth)

42586 MOMENTUM-TRANSFER-INDEPENDENT ANGULAR RELATIONS AND SOLUTIONS TO THE ISOSPIN-FACTORED CURRENT ALGEBRA. Chang, Shau-jin; Dashen, Roger; O'Raifeartaigh, L. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 182: 1819-36(June 25, 1969).

A general class of solutions to the isospin-factored algebra of form factors at infinite momentum is constructed. Lorentz covariance imposes a very restrictive condition on these form factors, which is known as the angular condition. This angular condition is decomposed into a set of momentum-transfer-independent conditions. To further simplify the problem, the angular conditions are strengthened into three more restrictive and mutually exclusive classes of conditions (called primitive equations). These simplified angular conditions can be solved completely, and lead to three classes of primitive solutions. It is found that for each of the primitive solutions there always exists an internal Lorentz group, and that these solutions are related to some very simple infinite-component wave equations. Having established the connection between the solution to the angular conditions and the wave equation, some very general solutions are constructed from the coupled wave equations. The fact that these coupled equations represent the most general solutions to the primitive equations suggests that they may already represent the most general solution compatible with the original angular condition. Next, under very mild technical conditions, the solutions to the angular conditions are shown either to be physically trivial or to contain a spacelike ($M^2 < 0$) part. The possibility that the spacelike and timelike parts are not coupled by the currents is also discussed. (auth)

42587 PROPERTIES OF CURRENT ALGEBRA AT INFINITE MOMENTUM. Chang, Shau-jin; Dashen, Roger; O'Raifeartaigh, L. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 182: 1805-18(June 25, 1969).

The sum rules of current algebra at infinite momentum can be considered as a system of coupled matrix equations, which is called the algebra of form factors. In addition to the equations following from sum rules, the form factors must also satisfy a complicated kinematic relation known as the angular condition. Presumably, the set of all hadron states (including the continuum) provides the basis for a representation of the algebra of form factors in which the angular condition is satisfied. It was conjectured by Dashen and Gell-Mann that a much smaller set of states containing only stable and resonant hadrons might also provide a representation. If this is true, the algebra of form factors could be used to predict many properties of hadrons. In the following paper, the problem of finding a representation in which the angular condition is satisfied and in which all states have the same isospin is considered. A large class of solutions is obtained which is suspected to actually include all solutions. None of the solutions has a physically acceptable mass spectrum. One purpose of the present paper is to discuss, in the proper physical context, the implications of the above-mentioned result. The algebra of form factors and the angular condition in detail are discussed, stressing those features which are general and not restricted to particular solutions. It is shown, for example, how additional equations following from the commutators of time components of currents can be incorporated with space components. The special problem of finding representations where all states have the same isospin is then considered. The relevance of this problem in the program of Dashen and Gell-Mann is discussed in detail. (auth)

42588 ASYMPTOTIC REPRESENTATION OF THE THREE-BODY WAVE FUNCTION IN THE REGION OF THREE-PARTICLE COLLISIONS. Shcherbin, Yu. P. Vestn. Leningrad. Univ., No. 4, Ser. Fiz. Khim., No. 1, 46-51(Feb. 1969). (In Russian).

The question about obtaining a three-body wave function in the region of three particle collisions is considered with the help of eigenfunctions of the characteristic one-dimensional equations. The quality of the functions for different representations is defined by a number of numerical examples. (auth)

42589 CHIRAL DYNAMICS AND SPECTRAL-FUNCTION SUM RULES. Fayyazuddin; Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan). Phys. Rev., 182: 1617-22(June 25, 1969).

A model based on the nonlinear chiral-invariant Lagrangian is discussed and is shown to be incompatible with the spectral-function sum rules. It nevertheless gives results about masses and decay widths of nonstrange vector and axial-vector particles in agreement with experiments. These results are the same as those obtained by Gilman and Harari on the basis of superconvergence dispersion relations. They are not compatible, however, with the results obtained from the hard-pion technique or the gauge-invariant Lagrangian of the Yang-Mills type. It is argued that in the nonlinear chiral-invariant Lagrangian theory, where one does not introduce vector and axial-vector particles as gauge fields, the Schwinger terms for vector and axial-vector currents are not equal, in contrast to the phenomenological gauge-invariant Lagrangian of the Yang-Mills type. The experimental implications of of the results obtained in these two models are discussed. (auth)

Electromagnetic

Refer also to abstracts 42007, 42008, 42637, 42666, 42716, 42720, 42721, 42725, 42726, and 42778.

42590 (JINR-P1-4529) DEPENDENCE RANGE–ENERGY FOR FAST ELECTRONS. Vzorov, I. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1969. 7p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Empirical relations between the range and the energy of electrons, valid for the energies 20–1000 MeV, are given. These relations are $R = a(\ln T)^b$, $T = (c)^{R^{1/b}}$, where a, b, and c are the parameters depending on Z the atomic number of the stopping material. For b and c as well as for a^{-1} the dependence on Z can be presented as follows: $\alpha \cdot e^{-\beta Z} + \gamma \cdot Z^{-\delta}$. (auth)

42591 (JINR-P4-4532) ACCOUNT OF POSSIBLE EXPERIMENTAL RESTRICTIONS BY CALCULATING RADIATIVE CORRECTIONS TO πe SCATTERING. Bardin, D. Yu.; Semikoz, V. B.; Shumeiko, N. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The radiative corrections to πe–scattering were calculated for the experiment in which finite particle energies and the angle of emission of recoil meson are measured. The conditions are pointed out under which the obtained results are valid for the case when the angle of emission of recoil electron is measured in addition and the momentum complanarity is checked. (auth)

42592 PROOF OF THE IMPOSSIBILITY OF THE $\gamma + Z \rightarrow Z + \nu + \tilde{\nu}$ PROCESS. Shpilevskii, A. (Inst. of Physics and Astronomy, Tallin). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 18: 209-14(1969). (In Russian).

The impossibility of the $\gamma + Z \rightarrow Z + \nu + \tilde{\nu}$ process is proved by means of a new calculation method and consideration connected with γ_5-invariation. A detailed analysis of the contradiction of Rosenberg's calculation is given. (auth)

42593 THE VENEZIANO AMPLITUDE, CURRENT ALGEBRA, AND THE ELECTROMAGNETIC PION FORM FACTOR. Mathur, V. S.; Olesen, P.; Rashid, M. A. (Univ. of Rochester, N. Y.). Phys. Lett., 29B: 514-17(July 21, 1969).

A Veneziano amplitude for the virtual pion Compton scattering is written down and compared with the soft-pion amplitude. A soft-pion expression for the pion electromagnetic form factor is derived. The intercept of the I = 2 trajectory is calculated. (auth)

42594 THEORY OF THE ELECTROMAGNETIC PRODUCTION OF VECTOR MESONS. Clark, Robert Beck. New Haven, Yale Univ., 1968. 103p.

Thesis.

The problem of the electromagnetic production of vector mesons was studied. The general kinematical structure is discussed and a set of invariant amplitudes is given. A technique was found for performing the complicated calculations which arise in diagrammatic models by computer. These techniques are then applied to two rather interesting problems. The contribution made by the exchange of a vector meson to the $\gamma + n \rightarrow \rho^- + p$ differential cross section is calculated and it is shown that information may be obtained from this process regarding the magnetic dipole and electric quadrupole moments of the ρ. A model considering the contribution of the s-channel resonances to the $\gamma + p \rightarrow \rho^0 + p$ differential cross section is studied, and promising results are obtained from a combination of the one pion exchange with form factor and the N(1680) $5/2^-$ resonance. (Diss. Abstr.)

42595 HADRONIC VACUUM POLARIZATION AND g_μ-2. Bell, J. S.; de Rafael, E. (CERN, Geneva). Nucl. Phys., B11: 611-20(1969).

The possibility of bounding the hadronic vacuum polarization contribution to the muon magnetic moment anomaly is considered. A proposed theoretical bound, based on the hypothesis of field current identity, is found not to add usefully to the vector meson dominance estimate. However, it is observed that improved electron-electron scattering experiments will yield a useful empirical bound. (auth)

42596 VECTOR DOMINANCE PREDICTIONS FOR THE REACTIONS $\gamma N \rightarrow \pi N^*$. Dar, A. (Technion-Israel Inst. of Tech., Haifa. Massachusetts Inst. of Tech., Cambridge). Nucl. Phys., B11: 634-40(1969).

Predictions based on the vector dominance model for photoproduction agree well with recent measurements of the reaction $\gamma p \rightarrow \pi^- N^{*2+}$. (auth)

42597 CALCULATION OF THE EFFECT OF VELOCITY DEPENDENT FORCES ON THE BREMSSTRAHLUNG CROSS SECTION USING SUM RULES. Mercado , G.; Rojo, O. (Escuela Superior de Fisica y Matematicas, Mexico City). Rev. Mex. Fis., 18: 75-86(1969). (In Spanish).

The effect of two-body correlations between nucleons due to velocity-dependent forces on the bremsstrahlung cross section is discussed using sum rule calculations. It is found that the velocity-dependent part of the potential introduces a change of less than one per cent in the results obtained by K. Okamoto for the same problem using a static potential. (auth)

42598 PHOTON-VECTOR-MESON ANALOGY MODEL AND PION ELECTROPRODUCTION: HOW TO CHECK EXPERIMENTALLY THE EXTRAPOLATION EFFECT OF THE SCATTERING AMPLITUDES FROM NONZERO MASS TO THE PHOTON MASS. Iso, Chikashi; Yoshii, Hiroaki (Tokyo Inst. of Tech.). Ann. Phys. (N. Y.), 51: 490-5(Feb. 15, 1969).

The general relation between pion electroproduction and vector meson production by pions is given under the assumption of the vector-meson-photon analogy model. It is also proposed how to check the off-mass-shell effect on the scattering amplitude for the $\pi N \rightarrow VN$ process. (auth)

42599 RELATIVISTIC AND GAUGE-INVARIANT MODEL OF NUCLEON-NUCLEON BREMSSTRAHLUNG. Baier, R.; Kuehnelt, H.; Urban, P. (Univ., Graz). Nucl. Phys., B11: 675-91(1969).

Nucleon-nucleon bremsstrahlung cross sections are calculated in the framework of the one-boson exchange model in a fully relativistic and gauge-invariant manner. For coplanar and noncoplanar events and also for the Rochester geometry in the proton-proton as well as the proton-neutron case the agreement with the experimental data is excellent for energies above 30 MeV. A strong dependence of the neutron-proton bremsstrahlung cross sections on the polar angle and on the non-coplanarity has been found with interesting implications for future experiments. (auth)

42600 EXPERIMENTAL LIMITS FOR THE ELECTRON-PROTON CHARGE DIFFERENCE AND FOR THE CHARGE ON THE NEUTRON. Fraser, Lawrence Jackson. New Haven, Yale Univ., 1968. 179p.

Thesis.

The upper limits to the electric charges on the cesium and potassium atoms were measured by the method of studying the deflection on an atomic beam in a homogeneous electric field. The results are: $|q(Cs)| \leq 2.3 \times 10^{-18} q_e$ and $|q(K)| \leq 1.6 \times 10^{-18} q_e$, where q_e is the absolute value of the electron charge. These results imply that the electron-proton charge difference is less than $4.5 \times 10^{-19} q_e$ and, independently, that the charge on the neutron is less than $3.4 \times 10^{-19} q_e$. Under the assumption of charge conservation in the beta decay of the neutron, the charge on the neutrino is shown to be less than $7.9 \times 10^{-19} q_e$, or if the neutrino is taken to have zero charge, then the electron-proton charge difference is equal to the neutron charge and both are shown to be less than $1.7 \times 10^{-20} q_e$. These upper limits, which are about two orders of magnitude lower than previous measurements on individual atoms, are considered to be consistent with the usual view that atoms are electrically neutral and to be determined primarily by small systematic errors caused by insulating films formed on the electric field plates from trace hydrocarbon contamination. The relevance of these measurements of atomic neutrality to the theory of elementary particles, to astrophysics and cosmology, and to the theory of relativity is discussed. (Disser. Abstr.)

42601 TWO PHOTON EXCHANGE IN ELECTRON-PROTON SCATTERING. Greenhut, Gary Kalman. Ithaca, N. Y., Cornell Univ., 1968. 155p.

Thesis.

An investigation is made of the two photon exchange contribution to electron-proton scattering. The contribution to the differential scattering cross section is calculated using both the second Born approximation and the distorted wave approximation. Potentials representing the charge distribution and magnetic moment distribution of the proton are used. Recoil proton polarization is calculated using the second Born approximation. A fit to the proton Compton scattering data up to 1100 MeV is made using an amplitude composed of the proton Born terms, π^0 and η^0 exchange terms and Breit–Wigner resonance terms. The four nucleon resonances with masses less than 1700 MeV and elasticities into the π-N channel greater than 50% are used. The resulting amplitude is extended to the case of off mass shell photons and the resonance portion used to calculate the resonance contribution to electron-proton scattering. At high energies the resonant and nonresonant contributions to the two photon exchange effect tend to cancel, the sum never exceeding 1% of the lowest order contribution to electron-proton scattering. (Disser. Abstr.)

42602 INVESTIGATION OF PROTON AND PION IONIZATION PRODUCED IN A STREAMER CHAMBER. Schoen, Neil Charles. Bethlehem, Pa., Lehigh Univ., 1968. 92p.

Thesis.

The dependence of the streamer density per unit length of track on the momentum of protons and pions was measured using a helium filled streamer chamber. Photographs of streamer chamber tracks were taken in the 15°-right beam in the external beam area of the Princeton–Pennsylvania Accelerator. The resultant streamer density distributions and streamer gap distributions were fitted by the χ^2 and least squares methods to the expected forms corrected for experimental errors. The mean streamer densities obtained from the fits were then compared to the values predicted for the number of ion pairs by the Bethe formula. The results, after inclusion of streamer reducing effects, are in approximate agreement with theory. (Disser. Abstr.)

42603 NUMERICAL CALCULATION OF CHARGED PARTICLE TRAJECTORIES ACCORDING TO THE DISCRETE POTENTIAL DISTRIBUTION. Strashkevich, A. M.; Grigorishin, I. L. (Electronic Lab., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 71-9(1968). (In Russian).

Certain methods for the numerical calculation of a relativistic charged particle according to the discrete potential distribution using the effective potential method are considered. The first method was based on the accurate integration of the equations of motion for the elementary square of the differential lattice with a stability condition for a given quadratic component of the effective field potential. The method was extended to the case of relativistic electron motion in crossed fields. The second method was based on the use of the equation for the trajectory in a general form and the solutions of the Dicke problem for a rectangle, the peaks of which coincide with the nodal points of the differential lattice. Also it is supposed that the potential is varied linearly in the directions of the rectangle. Certain considerations relative to the use of a computer for the calculation of relativistic charged particle trajectories were expressed. (tr-auth)

42604 REPRESENTATION OF THE FUNCTION OF ELEMENTARY PARTICLE IONIZATION LOSSES IN ENERGY AS A SIMPLE APPROXIMATING FUNCTION OF THE FORM β^{-a}. Khrimyan, A. V.: Koshtoev, V. V. Kosm. Luchi, No. 10, 122-3(1969). (In Russian).

A mathematical representation of the function of the ionization losses of energy by elementary particles as a simple approximating function of the form β^{-a} is given. (auth)

42605 PROTON-PROTON BREMSSTRAHLUNG. Burnett, Thompson Humphrey. San Diego, Calif., Univ. of California, 1968. 82p.

Thesis.

A covariant formulation of nucleon-nucleon bremsstrahlung is presented which is unitary, gauge invariant and has a relatively simple form in the soft-photon limit. Applying the soft-photon approximation to experiment, a large discrepancy is found with noncoplanar data taken in the Harvard geometry, while the fit for the coplanar case is good. The inclusion of nonsoft photon dynamics using S-matrix methods is discussed. (Disser. Abstr.)

42606 ELECTRODYNAMICS OF VECTOR MESONS. Grant, Charles Theodore. Bethlehem, Pa., Lehigh Univ., 1968. 101p.

Thesis.

The interaction of the massive charged vector field with the electromagnetic field is investigated. The most general Lagrangian density for the vector field which is bilinear in the field and its first derivatives is considered. The electromagnetic interaction is introduced minimally by the usual replacement $\partial_\mu \rightarrow \partial_\mu - ieA_\mu$. The self-energy parts of the vector meson and of the photon are examined to second order in the electric charge. It is demonstrated that the matrix elements corresponding to these interactions can be renormalized in principle if the vector particle is assumed to have an electric dipole moment and a magnetic moment each of one meson magneton. This implies that a parity nonconserving, time reversal noninvariant term should be included in the free Lagrangian density of the meson. The necessary renormalizations are carried out. These considerations are extended to the second order radiative corrections of the single-photon vertex. It is found that the more divergent terms of the interactions are canceled by the Ward identity. However, there still remain certain logarithmically divergent terms which appear to be nonrenormalizable. (Disser. Abstr.)

42607 THE ELECTROMAGNETIC FORM FACTORS OF THE NUCLEON FROM SIDEWISE DISPERSION RELATIONS. Silverman, Dennis Joseph. Stanford, Calif., Stanford Univ., 1968. 137p.

Thesis.

The electromagnetic form factors of the nucleon are studied by analytic continuation in the mass of one of the external nucleons of the electromagnetic vertex. The motivation is to remove a discrepancy between the calculated and experimental nucleon radius and to understand the behavior of the form factors at large momentum transfers. The analytic properties in nucleon $(\text{mass})^2 = W^2$ for spacelike photon mass $l^2 \leq 0$ are expressed in the sidewise dispersion relations first developed by Bincer. Bincer kept only the one pion-nucleon intermediate state in computing the absorption part: $N(W^2) \rightarrow N + \pi \rightarrow N + \gamma(l^2)$. This was expressed in terms of the pion nucleon vertex with one nucleon off mass shell $N(W^2) \rightarrow N + \pi$ and the multipoles for electropion production $\gamma(l^2) + N \rightarrow N + \pi$. Building on Bincer's formulation it is assumed that the threshold contribution to the absorptive part dominates the dispersion relation, and the multipoles for electropion production are calculated using the low energy theorem derived from PCAC and current algebra by Adler and Gilman. Threshold dominance in a sidewise dispersion relation was found to account for the anomalous magnetic moments of the electron and nucleon by Drell and Pagels. This assumption is further tested by calculating the electron's $F_2(l^2)$ form factor in order α. It is found that whereas threshold dominance works very well for the electron's radius and anomalous magnetic moment, it gives poor results at large momentum transfers. It is found that one can account for the isovector magnetic moment and isovector radius of the nucleon's $F_2^V(l^2)$ form factor. From the qualitative result for the isovector radius, it is concluded that the nucleon's electromagnetic radius is larger than the pion's due to the large range of the nucleon's pion cloud. Also the magnitude of the F_1 radius is accounted for. However, poor results are obtained for the isoscalar form factors at small l^2. This is because the dominant threshold amplitude is pure isovector and does not contribute to this case. At large momentum transfers $l^2 \rightarrow -\infty$, a small threshold contribution in the sidewise dispersion relations for $F_2(l^2)$ is found. (Disser. Abstr.)

42608 VECTOR-DOMINANCE MODEL AND η PHOTOPRODUCTION. Gorczyca, B.; Hayashi, M. (Jagellonian Univ., Krakow). Acta Phys. Pol., 36: 47-51(July 1969).

The relation between the η-photoproduction cross section and strong vector meson production cross sections is derived under the assumption of vector meson dominance in the framework of the Regge-pole model with SU(3) symmetry (taking into account the exchange of ρ, ω and B trajectories) and neglecting the contribution of φ-meson production by the η-meson. It is shown that the relation is well satisfied using available experimental data. (auth)

42609 VECTOR DOMINANCE MODEL AND CHARGED PION PHOTOPRODUCTION SUM RULES. Hayashi, M. (Jagellonian Univ., Krakow). Acta Phys. Pol., 36: 53-7(July 1969).

It is shown that SU(3) × SU(3) symmetry with the vector dominance model (VDM) allows one to derive the photoproduction sum rules derived previously on the basis of the quark model and VDM. (auth)

42610 FLUCTUATIONS IN THE ANGULAR DISTRIBUTION OF PARTICLES IN THE PHOTON-ELECTRONIC SHOWERS. Gedalin, E. V. Kosm. Luchi, No. 10, 119-21(1969). (In Russian).

The fluctuations of the number of particles in the three-dimensional cascade theory without Landau approximation are examined. Mathematical calculation of the angular distribution of particles in a photon-electronic shower is presented. (auth)

42611 CALCULATION OF THE TRANSITION EFFECT IN ELECTROMAGNETIC CASCADES FOR DEPTHS BEYOND SHOWER MAXIMUM. Crannell, Carol Jo (Catholic Univ. of America, Washington, D. C.). Phys. Rev., 182: 1441-2(June 25, 1969).

A model of the propagation of electromagnetic cascade showers for depths beyond shower maximum is used to calculate the magnitude of the transition effect from lead to Plexiglas. The results of the calculation compare favorably with previously determined experimental results. (auth)

42612 ELECTROMAGNETIC PROPERTIES OF THE NUCLEON RESONANCE N' (1470). Muta, Taizo (Univ. of Wisconsin, Milwaukee). Phys. Rev., 182: 1507-11(June 25, 1969).

By applying the sidewise dispersion relation to the electromagnetic, π-N, and gravitational vertex functions of the nucleon and N'(1470) while dominating the intermediate states by one-particle states, it is shown that the magnetic form factor of N'(1470) and the magnetic transition form factor between N'(1470) and the nucleon are proportional to the magnetic form factor of the nucleon with known proportionality constants. It is also shown that the electromagnetic mass difference of N'(1470) is proportional to the p-n mass difference with the same proportionality constant. (auth)

42613 MODIFICATIONS OF VECTOR-MESON DOMINANCE IN PHOTOPRODUCTION. Meiere, F. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 182: 1561-3(June 25, 1969).

It is suggested that a dispersion approach provides an unambiguous formulation of vector-meson dominance. Discussion is given of the problem of subtraction constants and their possible use in explaining the present discrepancy between polarized-photoproduction experiments and conventional formulations. (auth)

42614 HIGH-ENERGY COLLISION PROCESSES IN QUANTUM ELECTRODYNAMICS. IV. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., 182: 1899-1906(June 25, 1969).

The rather complicated asymptotic behavior at high energies found in the preceding paper for the Delbrück-scattering matrix element is recast in a simpler form. This is accomplished by introducing a suitable form factor in the transverse plane. This factor, called the impact factor of the photon, also appears in other processes. Moreover, it is verified that the transverse momentum transfer is small in Delbrück scattering. (auth)

42615 RELATIONS BETWEEN ELECTRON AND PROTON EXCITATION OF N* RESONANCES. Rubenstein, Allen (Stanford Univ., Calif.). Contract F44620-68-C-0075. Phys. Rev., 182: 1748-54(June 25, 1969).

Various theories which relate the elastic electromagnetic form factors of the proton to the proton-proton scattering amplitude are briefly reviewed, and are extended in turn to diffractive excitation processes. Only very high-energy scattering $s \gg m^2, M^2$, where m (M) is the proton (resonance) mass is considered. For large momentum transfer $X = G_E^{-2}(t)\ (|f_c|^2 + a\ |f_t|^2/|t|)m/M + O(1/s)$, where X is the ratio of $d\sigma/dt$ for $p + p \rightarrow p + N$ to that for $p + p \rightarrow p + p$, and the f's are the standard inelastic electromagnetic form factors, $a = (2J + 1)/J$. For small momentum transfer both an additive quark model and an eikonal scattering model are employed. In both models a direct connection is found between X and the electromagnetic form factors. The comparison of these theories with available data is very encouraging. (auth)

42616 VECTOR MESONS AND NUCLEAR OPTICS. Gottfried, K. (Massachusetts Inst. of Tech., Cambridge); Yennie, D. R. Contract AT(30-1)-2098. Phys. Rev., 182: 1595-1601(June 25, 1969).

The implications of vector dominance for the optical properties of complex nuclei are examined. Particular attention is paid to the transition from the low-energy regime where the nucleus acts as a transparent object to the high-energy regime where the photonuclear cross sections have some of the characteristics of shadow scattering. This transition occurs in the energy range available to existing accelerators. The energy dependence of total photoabsorption and inelastic cross sections are calculated and found to be appreciable; they are therefore amenable to experimental study. (auth)

42617 PHENOMENOLOGICAL ANALYSIS OF SINGLE-PION PHOTOPRODUCTION. Walker, R. L. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 182: 1729-48(June 25, 1969).

A phenomenological fit of the data on single-pion photoproduction is presented for laboratory photon energies up to 1.2 BeV. The analysis is made in terms of a simple model in which the photoproduction amplitude consists of three separate contributions: (1) the Born approximation with electric coupling only; (2) Breit–Wigner resonances for which the positions and widths are taken from pion-nucleon scattering data, but whose amplitudes are adjustable parameters; and (3) additional contributions in the low partial waves having $J = 1/2$, $3/2$, and $5/2$. A criterion for success of the model is that these added terms, which are the principal adjustable parameters, should vary smoothly with energy. Most of the resonances found in the phase-shift analysis of pion-nucleon scattering are included in the fit. In particular, there is reasonably good evidence in the photoproduction data for a broad S-wave resonance near 1560 MeV. The analysis is carried out in terms of the helicity-amplitude formalism, which is more convenient for this purpose than the conventional representation in terms of multipole amplitudes. (auth)

42618 HIGH-ENERGY COLLISION PROCESSES IN QUANTUM ELECTRODYNAMICS. I. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., 182: 1852-67(June 25, 1969).

A systematic study was made of all two-body elastic scattering amplitudes in quantum electrodynamics at high energies. In particular, the high-energy behavior of the following processes were calculated: (1) Delbrück scattering, (2) electron Compton scattering, (3) photon-photon scattering, (4) electron-electron scattering, (5) electron-positron scattering, and (6) electron-proton scattering. The processes (1) and (2) are calculated up to the sixth order in the coupling constant e, the process (3) up to the eighth order, and the processes (4), (5), and (6) up to the fourth order. The calculations show that all of these amplitudes are proportional to s, the square of the center-of-mass energy, as s becomes large. In other words, it was found that, to these orders, $\lim_{s\to\infty} d\sigma/dt$ exists and is nonzero for all $t \neq 0$, where $-t$ is the square of the momentum transfer. Furthermore, it was found meaningful to assign a factor (we call it the impact factor) to each particle. More precisely, for the high-energy scattering of $a + b \to a + b$, the imaginary coefficient for s for the scattering amplitude is proportional to $\int dq_\perp [(q_\perp + r_1)^2]^{-1} [(q_\perp - r_1)^2]^{-1} I^a(r_1,q_1)\, I^b(r_1,q_\perp)$, where $2r_1$ is the momentum transfer, and $I^a(r_1,q_\perp)$ and $I^b(r_1,q_\perp)$ are the impact factors of particles a and b, respectively. The integration is over the two-dimensional transverse momentum of the virtual photons. The important point is that I^a (I^b) does not depend on what particle b (a) is. The impact factors were explicitly found for the photon (up to e^4) and for the electron, the positron, and the proton (up to e^2). In the case of Delbrück scattering, all higher-order diagrams with an arbitrary number of photons exchanged between the virtual pair and the proton or nucleus were treated. The coefficient of s in this case can be expressed as the integral of the above-mentioned product $I^a\, I^b$ times modified photon propagators. The impact factor therefore appears to express an intrinsic property of a particle. The result is consistent with neither the most straightforward interpretation of the Regge-pole model nor that of the droplet model. These inconsistencies are closely related to the nonplanar nature of the diagrams under consideration. The results on Delbrück scattering are also qualitatively different from those of Bethe and Rohrlich based on the impact-parameter approximation. (auth)

42619 HIGH-ENERGY COLLISION PROCESSES IN QUANTUM ELECTRODYNAMICS. II. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., 182: 1868-72(June 25, 1969).

All the high-energy scattering processes $a + b \to a + b$ in quantum electrodynamics are considered, where a and b can be fermions or antifermions. Aside from the photon pole terms, these high-energy amplitudes are shown to be conveniently expressed by the impact factors. The impact factors for the electron, the positron, and the static nucleus are explicitly given. (auth)

42620 HIGH-ENERGY COLLISION PROCESSES IN QUANTUM ELECTRODYNAMICS. III. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., 182: 1873-98(June 25, 1969).

The asymptotic behavior of the matrix elements at high energies is obtained explicitly for Delbrück scattering, i.e., the elastic scattering of a photon by a static Coulomb field via a virtual electron-positron pair. This is the simplest nontrivial two-body elastic scattering process in quantum electrodynamics besides those discussed in the preceding paper. The considerations are limited to the lowest order, Z^2e^6, for the matrix elements, and it is found that, to this order, $\lim_{\omega\to\infty} d\sigma/dt$ exists and is nonzero for any fixed positive momentum transfer. This limiting value is expressed in terms of integrals, which are evaluated numerically. The behavior of these integrals is also studied in detail for the cases where the momentum transfer is either much larger or much smaller than the mass of the electron. Moreover, the scattered photon is significantly polarized in the scattering plane. None of the present results agree with the earlier ones of Bethe and Rohrlich using the impact-parameter approximation. (auth)

42621 NONSTATIC RELATIONS BETWEEN MAGNETIC MOMENTS IN THE QUARK MODEL. Franklin, Jerrold (Temple Univ., Philadelphia). Phys. Rev., 182: 1607-9(June 25, 1969).

Relations between baryon magnetic moments are derived which are independent of orbital corrections, relativistic corrections, and two-body exchange corrections (and generally any two-body correction) in the quark model, provided that the wave-function contributions leading to these corrections are SU(3)-symmetric. Among the relations derived are $\mu(\Xi^-) + 3\mu(\Xi^0) = 6\mu(\Lambda) + 2\mu(\Sigma^+) - 3\mu(p) - \mu(n)$ (independent of quark moments) and $\mu(\Xi^0) - \mu(\Xi^-) = \mu(p) + 2\mu(n)$ (if $\mu_{\mathcal{P}} = -2\mu_{\mathcal{N}}$). (auth)

42622 ANOMALIES OF THE AXIAL-VECTOR CURRENT. Jackiw, R. (Harvard Univ., Cambridge, Mass.); Johnson, K. Contract AT(30-1)-2098. Phys. Rev., 182: 1459-69(June 25, 1969).

The anomalies of the neutral axial-vector current, of its divergence, and of its commutators in the presence of electromagnetic interactions are exhibited. It is shown that it is impossible in perturbation theory to maintain minimality of electromagnetic interactions, gauge invariance, and partial conservation of axial-vector current (PCAC). The departures from gauge invariance or PCAC which are necessitated by minimality are established. The relevance of the present considerations to $\pi^0 \to 2\gamma$ decay is discussed. (auth)

42623 SOME COMMENTS AND A PREDICTION CONCERNING THE DECAY $K_2^0 \to \gamma\gamma$. Rockmore, Ronald (Imperial Coll. of Science and Tech., London). Phys. Rev., 182: 1512-16(June 25, 1969).

It is shown how only pseudoscalar (π^0,η) and vector ($K^{*(8)}$) poles need be considered in a pole-model analysis of the decay $K_2^0 \to \gamma\gamma$. The calculation of the decay amplitude is presented in detail, both in an SU(3)-symmetric model of VVP couplings with $\phi\omega$ mixing, and and in a model (due to Arnowitt et al.) of PCAC breakdown with partial SU(3) symmetry, which fits the decay rates of $\pi^0 \to \gamma\gamma$ and $\eta \to \gamma\gamma$ reasonably well. It is found that the pseudoscalar and vector contributions add, instead of partially canceling as claimed by earlier workers, so that theory and experiment are no longer in reasonable agreement. Moreover, a separate calculation of the important vector pole contribution to the decay amplitude in the free-field quark model yields no significant diminution of its SU(3) magnitude. (auth)

42624 VENEZIANO PARAMETRIZATION FOR NONSTRONG AMPLITUDES. Brower, R. C.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., 182: 1779-84(June 25, 1969).

Veneziano-like parametrizations are found for photoproduction, Compton scattering, and current algebra. (auth)

42625 PHENOMENOLOGICAL MASS-SPLITTING PARAMETERS AND A CURRENT–CURRENT THEORY. Clavelli, L. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., 182: 1770-2(June 25, 1969).

Deviations from the Gell-Mann–Okubo formula for various multiplets of elementary particles are predicted by saturating an energy-momentum tensor of the Sugawara type by octet states. (auth)

42626 PHOTON–NUCLEUS TOTAL CROSS SECTIONS. Brodsky, Stanley J.; Pumplin, Jon (Stanford Univ., Calif.). Phys. Rev., 182: 1794-1804(June 25, 1969).

Quantitative predictions for the energy and A dependence of the cross sections for nuclear photoabsorption and inelastic electron-nucleus scattering are given. In general, the nucleons do not contribute equally to the total photon-nucleus cross section when coherent contributions of photoproduced hadrons are taken into account. At low energies ($E_\gamma \sim 1$ BeV), the cross sections are proportional to nuclear number A, but at high energies, they become proportional to the number of surface nucleons—provided that the photon interactions are mediated by hadrons of sufficiently low mass. The condition on the masses is that the momentum transfers in forward photoproduction of these states should be small compared to the reciprocals of their mean free paths in nuclear matter. In the case of ρ dominance, the real-photon photoabsorption cross section has the same A dependence as hadron-nucleus total cross sections for photon energies above $\approx$10 BeV, whereas the cross section for virtual photon absorption at that energy, obtained from inelastic electron scattering, is nearly proportional to A for spacelike momentum transfer $|Q^2| \gtrsim 5\ \text{BeV}^2$. A generalization is made to an arbitrary spectrum of intermediate particles, and the sensitivity of feasible experiments to various models in which the spectrum contains important structure beyond the ρ is discussed. Measurements of the photon-nucleus cross sections will provide a fundamental test of "hadron dominance" in general, and of ρ-ω-ϕ dominance in particular, as well as help to determine the basic parameters of photon-nucleon and ρ-nucleon interactions. The photon-deuteron cross section is also calculated and the multiple scattering approach to the photon-nucleus interactions is discussed. This discussion provides insight into the many-body processes which underlie the eikonal, optical-model calculations; it is also relevant to the determination of $\sigma_{\gamma n}$ at high energies. (auth)

42627 EXPERIMENTAL CONSEQUENCES OF THE ALGEBRA OF FIELDS. Sidhu, Deepinder P.; Dresden, Max (New York State Univ., Stony Brook). Phys. Rev. Lett., 23: 447-9(Aug. 25, 1969).

The commutation rules of the algebra of fields were applied to predict sum rules for the electric-dipole moment and the magnetic-quadrupole moment of nucleons. In the calculation it was assumed further that the sum rule could be saturated by just one state [N**(1518)]. The resulting consistency condition obtained is in striking conflict with experimental results. The identical condition is obtained if one assumes saturation of the sum rule by an arbitrary number of one-particle states. This failure of the consistency condition based on the algebra of fields is to be contrasted with the reasonable success of the corresponding relation based on current algebra and saturation by the same single state. (auth)

42628 PHOTON-PHOTON SCATTERING CONTRIBUTION TO THE SIXTH-ORDER MAGNETIC MOMENT OF THE MUON. Aldins, Janis (Cornell Univ., Ithaca, N. Y.); Kinoshita, Toichiro; Brodsky, Stanley J.; Dufner, Andrew J. Phys. Rev. Lett., 23: 441-3(Aug. 25, 1969).

A calculation of the three-photon-exchange (electron-loop) contribution to the sixth-order anomalous magnetic moment of the muon is reported. The result, which contains a logarithmic dependence on the muon-to-electron mass ratio, brings the theoretical prediction into agreement with the CERN measurements, within the 1-standard-deviation experimental accuracy. (auth)

42629 COMPTON SCATTERING SUM RULES AND THEIR SATURATION. Fox, Geoffrey C. (Univ. of California, Berkeley); Freedman, Daniel Z. Phys. Rev., 182: 1628-57(June 25, 1969).

Theoretical features of the many fixed-momentum-transfer dispersive sum rules which can be written for the 26 possible generalized nucleon Compton scattering amplitudes (retarded products of vector currents) are surveyed, and the sum rules are put to experimental test. Theoretical attention is focused on the occurrence of right-signature fixed poles in the angular momentum plane, such as the j = 1 fixed poles whose couplings are related to electromagnetic form factors by current algebra. Unitarity is used to estimate the sum-rule integrands in terms of data for the photoproduction processes $\gamma N \rightarrow \pi N$ and $\gamma N \rightarrow \pi\Delta$. Limitations of the data require that the sum rules be cut off at photon lab energy $E_{lab} = 1.12$ GeV. The main results are as follows: (a) Reasonable evidence is presented that two-time-component current-algebra sum rules involving the electric and magnetic isovector form factors $G_E^V(t)$ and $G_M^V(t)$ are correct for small spacelike $-t$. If they are also to be correct for $-t \gtrsim -0.6$ $(GeV/c)^2$, then the ρ Regge pole must choose nonsense at $\alpha = 0$, and the associated wrong-signature fixed pole there must be multiplicative. A time-space current-algebra sum rule probably fails. (b) The separate isotopic components of the Drell-Hearn sum rule are investigated. Those with I = 0 exchange in the t channel seem very successful, whereas the I = 1 exchange sum rule clearly fails. The failure indicates an important contribution of a hitherto unsuspected $J^P(I^G) = 1^+(1^-)$ fixed pole. (c) Detailed results on wrong-signature antialgebra sum rules, on Regge-pole sum rules (FESR's), and on sum rules testing conspiracy are presented. (auth)

Weak

Refer also to abstract 42623.

42630 (ISS-69/18) ON THE ORIGIN OF THE WEAK INTERACTION ANGLE. [PART] II. Cabibbo, N.; Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). May 2, 1969. 45p. Dep.

A theory of the origin of the weak interaction angle θ is presented based on a self-consistency condition linking weak, strong, and electromagnetic symmetry breaking effects. The value of θ is related to the observed pattern of breaking of SU(3) ⊗ SU(3), and depends upon the value of a new parameter ξ, which gives the strength of the weak corrections to strong processes. A characteristic result of the theory is the prediction of a nonelectromagnetic I-spin breaking. This solves the $\eta \rightarrow 3\,\pi$ puzzle and accounts for the observed deviation from the Dashen sum rule: $m^2_{K^+} - m^2_{K^0} = m^2_{\pi^+} - m^2_{\pi^0}$. Although one is not able to give a theoretical evaluation of ξ in a realistic model of weak interactions, a phenomenological determination of ξ is proposed, based on the observed I-spin breaking mass splittings among pseudoscalar mesons. In this way the prediction $\theta = 0.25$ is obtained which is in good agreement with the experimental value. (auth)

42631 HARD-MESON CURRENT ALGEBRA, K_{l3} DECAY, AND CHIRAL SYMMETRY BREAKING. Pande, L. K. (Ohio State Univ., Columbus). Phys. Rev. Lett., 23: 353-6(Aug. 11, 1969).

The K_{l3} decay parameters were calculated on the basis of the maximal information obtainable from hard-meson current algebra in the single-particle saturation approximation. The calculation includes fully the effects of the kappa meson reported recently by Trippe et al. It is noted that the results automatically lead to those following from chiral SU(3) ⊗ SU(3) broken with $(\underline{3}^*,\underline{3}) \oplus (\underline{3},\underline{3}^*)$. (auth)

42632 LEPTON SYMMETRY AND SELF-MASS. Pestieau, Jean; Roy, Probir (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 23: 349-51(Aug. 11, 1969).

The symmetry of leptonic weak and electromagnetic interactions unified in a model free of quadratic divergences is considered. Explicit values for intermediate boson masses and coupling constants are obtained from the requirement of finite self-masses for leptons. (auth)

42633 FORM FACTOR RESOLUTION IN K_{l3} DECAY. Marateck, S. L. (Univ. of Pennsylvania, Philadelphia); Rosen, S. P. Phys. Lett., 29B: 497-500(July 21, 1969).

It is shown that in K_{l3} decay, the lepton-neutrino correlation in the π-ν cm system is linear. This is used to demonstrate the virtual impossibility of determining an upper limit on f_s/f_+ which is significantly less than 2%. This leads to an intrinsic uncertainty in ξ of 0.2 and could result in the measured value of λ_- differing from the actual value by as much as an order of magnitude. (auth)

42634 UNIVERSALITY OF THE WEAK-VECTOR COUPLING CONSTANT. Dicus, Duane Alfred. Los Angeles, Univ. of California, 1968. 110p.
Thesis.

In the V-A theory of weak interactions with coupling constant G, whether or not it is mediated by an intermediate vector meson, it is shown to order αG that the contribution of the vector hadron current to the Fermi part of the amplitude for β-decay involving hadrons in the same isomultiplet is independent of the details of the strong interactions. This contribution to the radiative corrections to β-decay is reevaluated with results that agree in form with those obtained previously with the use of zero order perturbation theory in the strong interactions. The terms of order $GZ\alpha\, q\, \langle r \rangle$ do depend on the strong interactions and are evaluated using a model. The results of both orders are applied to some nuclear decays and it is shown that G is universal to within the experimental error. (Disser. Abstr.)

42635 PCAC AND INTERACTION CURRENT EFFECT IN TRITON BETA DECAY. Chemtob, M.; Rho, M. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett., 29B: 540-3(Aug. 4, 1969).

The low-energy theorem is used for the axial current to obtain the part of the interaction current contribution to nuclear beta decay coming from the "non-Born terms." In triton beta-decay this turns out to be quite substantial, but is cancelled mostly by the part of the "Born term" not included in the nuclear wave function. The effect of a repulsive core is also examined. (auth)

42636 SPECTRUM AND ASYMMETRY OF HIGH ENERGY NEUTRONS EMITTED IN THE ABSORPTION OF POLARIZED MUONS. Bogan, Alexander Jr. (Univ. of Virginia, Charlottesville). Nucl. Phys., B12: 89-109(1969).

The rate of production and the asymmetry of neutrons emitted directly with the capture of polarized muons are expressed in terms of single-nucleon integrals. This expression takes account of momentum-dependent terms to first order in the muon capture Hamiltonian and is suitable for calculations involving general neutron wave functions. When plane waves in nuclear matter are assumed for the neutron wave function, the calculated intensities and asymmetries are in agreement with recent experiments on silicon, sulfur and calcium. The momentum-dependent terms strongly affect the asymmetry but not the intensity, whereas the nuclear model seems to affect the intensity but not the asymmetry. (auth)

42637 ELECTROMAGNETIC EFFECTS IN K → 2π DECAYS. Wallace, D. J. (Univ. of Edinburgh). Nucl. Phys., B12: 245-56 (1969).

An estimate is made of the contributions to two types of electromagnetic mechanism to $K^+ \rightarrow \pi^+\pi^0$ decay, assuming that the weak Hamiltonian obeys the $\Delta I = 1/2$ rule. These mechanisms give about half of the $K^+ \rightarrow \pi^+\pi^0$ decay amplitude. The contributions to $K_1^0 \rightarrow \pi^0\pi^0$ and $K_1^0 \rightarrow \pi^+\pi^-$ from similar electromagnetic effects are examined. (auth)

42638 ON THE HYPERON DECAYS IN HEISENBERG'S THEORY. Segawa, Hiroshi (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1591-2(June 1969).

A possible mechanism of the weak interaction in Heisenberg's nonlinear field theory was previously proposed, which explained the main features of nonleptonic weak decays. Some results relating to $\Sigma \rightarrow N\pi$, $\Xi^- \rightarrow \Lambda\pi^-$, and $\Lambda^0 \rightarrow p\pi^-$ decays are obtained under the assumption that the parity of the decaying particle becomes indefinite after exchanging a spurion with the vacuum. (L.B.S.)

42639 THE GOLDBERGER-TREIMAN RELATION AND ITS KAON ANALOGUE AS A NON-GROUP-THEORETICAL KINEMATICS GENERATING AN SU(3) SYMMETRY. Okabayashi, Takao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 1566-77(June 1969).

Assuming the Sakata model a SU(3)-symmetry character of Fermi interaction is derived from the non-group-theoretical conditions $\partial_\mu(\bar{N}\gamma_\mu\gamma_5\tau_1 N) = 2m_{N0}(\bar{N}\gamma_5\tau_1 N)$ and $\partial_\mu(\bar{\Lambda}\gamma_\mu\gamma_5 N) = (m_{N0} + m_{\Lambda 0}) \times (\bar{\Lambda}\gamma_5 N)$. The latter conditions are weaker than the SU(3) symmetry and enable the Goldberger-Treiman relation and its kaon analogue to be reproduced through purely kinematical manipulations. Further, the γ-matrix dependence of the Fermi interaction is determined by the conditions. (auth)

42640 SPLITTING OF THE DEUTERON BY SOLAR NEUTRINOS. Kopysov, Yu. S.; Kuz'min, V. A. Kosm. Luchi, No. 10, 90-1(1969). (In Russian).

The cross section of the process $^2D + \nu \rightarrow {}^1H + {}^1H + e$ is calculated for the neutrino energies 4 MeV $\leq E_\nu \leq$ 20 MeV. Square well nuclear force potential functions were chosen as wave functions of the deuteron and the system of two protons. The uncertainty of the cross section is ±8%, largely due to the inaccuracy of the pseudovector constant. The cross section is well approximated by the function $\sigma(E_\nu) = 1.96 \cdot 10^{-44} (E_\nu/1 \text{ MeV} - 1{,}443)^{2.31}$ cm². Integral cross sections for ^8B- and ^3He p-solar neutrinos were obtained. The possibilities of using deuterium for solar neutrino detection are examined, and the characteristics of a deuterium scintillation detector are discussed. (auth)

42641 GENERATION OF NEUTRINO BY COSMIC RAYS IN RAREFIED AND DENSE MEDIA. Volkova, L. V. Kosm. Luchi, No. 10, 128-31(1969). (In Russian).

Muons and neutrinos generated by the primary cosmic radiation in dense objects lacking atmosphere are considered. Calculations of the spectra of the decay products of the particles which have exact power-law energy spectra are given as well as the calculations of the spectra of neutrinos generated by the primary cosmic radiation in rarefied media. (auth)

42642 DIFFERENCE BETWEEN THE CABIBBO ANGLES θ_A AND θ_V AND THE DECAYS K → 2π IN A COVARIANT QUARK MODEL. Gudehus, Timm (Univ. of Miami, Coral Gables, Fla.). Contract AF AFOSR 1268-67. Phys. Rev., 182: 1479-81(June 25, 1969).

Formulas for the amplitudes of the three weak hadronic decays $K^+ \rightarrow \pi^+ + \pi^0$, $K_1^0 \rightarrow \pi^+ + \pi^-$, and $K_1^0 \rightarrow 2\pi^0$ are derived within the framework of a covariant quark model. The result is that for the explanation of the observed $K^+ \rightarrow \pi^+ + \pi^0$ decay a slight difference between the Cabibbo angles θ_A and θ_V is required. A sum rule for the three decay widths and a calculation of the K_1^0 decay width are in fairly good agreement with the experimental data. (auth)

42643 K_{l4} DECAY IN AN ALGEBRAIC MODEL FOR MESONS. Boehm, A. (Univ. of Texas, Austin); Sudarshan, E. C. G. Phys. Rev., 182: 1918-20(June 25, 1969).

The associative algebraic model B which had previously been applied to the meson-spectrum problem and the two- and three-body leptonic decays of mesons was used to calculate the absolute rates for K_{l4} decays. It predicts $\Gamma(K_{l4}^+) = 3.47 \cdot 10^3$ sec^{-1} and $\Gamma(K_{l4}^0) = 0$, in agreement with the experimental data. (auth)

42644 PION-MASS EXTRAPOLATIONS AND PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT. Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev., 182: 1913-15(June 25, 1969).

It is proposed, as suggested by a recent study, that the observed 10% corrections to the Goldberger-Treiman relation cannot be accounted for on the basis of unsubtracted dispersion relations. To incorporate the possibility of a small subtraction in the matrix elements of the divergence of the axial-vector current, a supersmooth pion field is defined from the weak interactions by $i\partial_\mu A_\mu^{(+)}(x) = (2Mg_A\mu^2/\sqrt{2}g)\pi^{(+)}(x) - \Delta f_\pi \Box \pi^{(+)}(x)$, with $\Delta = 1 - 2Mg_A/\sqrt{2}gf_\pi \simeq +0.1$ representing the 10% correction. With this definition and the supersmoothness hypothesis the extrapolation of exact current-algebra threshold theorems for weak amplitudes to relate hadron amplitudes is relatively simple and eliminates a major ambiguity in performing such extrapolations in the virtual pion mass. (auth)

Strong (General)

Refer also to abstract 42642.

42645 THREE-TRIPLET MODEL, DUALITY, AND THE POMERANCHON. Greenberg, O. W. (Tel Aviv Univ., Israel). Phys. Lett., 29B: 493-6(July 21, 1969).

Duality diagrams in the three-triplet model are studied and identified with Regge and Pomeranchon exchanges. Using duality, a group theory classification of these diagrams is given, and some consequences of this classification are pointed out. (auth)

42646 INTERMEDIATE STATES IN THE t-CHANNEL AND THE STRONG INTERACTION RADIUS. Logunov, A. A.; Khrustalev, O. A.; Mestvirishvili, M. A.; Nguyen, fan Hieu. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B11: 692-8(1969).

It is shown that the indication of the connection between the effective interaction radius and the position of the nearest singularities in t and u channels allows one to estimate qualitatively the differential cross sections of a number of strong interaction processes. Backward elastic scattering is discussed in detail. (auth)

42647 BOOTSTRAPS AND SUM RULES IN THE STATIC MODEL. Gunson, J. Russell (Univ. of Durham, Eng. Carleton Univ., Ottawa). Nucl. Phys., B11: 667-74(1969).

A canonical method is found for solving the static model bootstrap problem for any arbitrary number of particles and an arbitrary symmetry group. The results are compared with those derived from the saturation of a superconvergence relation and first moment sum rule and a close equivalence is found which casts new light on the veracity of bootstrap calculations. (auth)

42648 SCALAR AMPLITUDES FOR TWO-BODY PROCESSES AND THE QUARK MODEL. Kotanski, Andrzej (Jagellonian Univ., Krakow); Zalewski, Kacper. Nucl. Phys., B12: 72-8 (1969).

The number of independent scalar amplitudes necessary to describe two-body scattering processes is reduced using the additivity of the quark model. Expressions given explicitly for the amplitudes imply all the relations of class (a) predicted by the quark model and a correct kinematical behavior for forward and backward scattering. (auth)

42649 NONCOPLANAR p-p BREMSSTRAHLUNG CALCULATIONS AT 48 AND 30 MeV. Drechsel, Dieter (Catholic Univ. of America, Washington, D. C.); Maximon, Leonard C.; Warner, Robert E. Phys. Rev., 181: 1720-2(May 20, 1969).

Cross sections for coplanar and noncoplanar proton-proton bremsstrahlung were calculated at 48 and 30 MeV, using the Hamada-Johnston potential. The coplanar results agree with those of Signell and Marker. The University of Manitoba p-p bremsstrahlung data were reanalyzed and new coplanar cross sections were extracted. (auth)

42650 THE REARRANGEMENT OF SAKATONS AND HIGH ENERGY TWO-BODY SCATTERING. II. Matsuoka, Takeo; Ninomiya, Kansuke; Sawada, Shoji (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1533-54(June 1969).

The differential cross section for the high energy inelastic two-body and quasi-two-body scatterings are investigated from the composite viewpoint which is proposed in a previous paper. The scattering amplitudes are given by a linear combination of twelve spin amplitudes of sakaton-sakaton and sakaton-anti-sakaton rearrangement under the assumption that the spectator sakaton does not change its spin state. Many sum rules among differential cross sections $d\sigma/dt'$ of various processes are derived where $t' = |t - t_{min}|$ and t is square of momentum transfer. These sum rules are examined in the energy around p_L = 10 GeV/c and the very forward region ($t' \lesssim 0.5(\text{GeV}/c)^2$). It is found that the agreement with experiment is satisfactory apart from a few exceptional processes.

Furthermore, a preliminary result on the energy and t′ dependence of the twelve spin amplitudes is obtained and found to be consistent with a generalized Pomeranchuk theorem and also with kinematical constraints. The results of the analysis may afford some evidences that the sakaton having one-half spin plays a significant role in the high energy phenomena. (auth)

42651 STRONG-COUPLING SOLUTION OF THE BRONZAN–LEE MODEL. Nickle, H. H. (Duke Univ., Durham, N. C.). Phys. Rev., 182: 1475-8(June 25, 1969).

An approximate solution of the nonrelativistic Bronzan–Lee model in all sectors is described. By using Tomonaga's intermediate-coupling approximation and then minimizing a strong-coupling approximation to the lowest set of energy eigenvalues, a relatively simple strong-coupling solution is obtained which avoids the restriction to large-source radius inherent in North's strong-coupling treatment. An explicit calculation is carried out for the special case $f = g \gg 1$, in which case one finds an isobar spectrum $E_q \sim (6q^2 - 1)g^{-2}$, where q denotes the total charge. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 42704 and 42761.

42652 PION–ΛΣ COUPLING FROM FORWARD SCATTERING DISPERSION RELATIONS. Weil, C. (Technion-Israel Inst. of Tech., Haifa). Phys. Lett., 29B: 501-2(July 21, 1969).

It has been proposed that the availability of the recent effective range multichannel K-matrix parametrization of low energy $\bar{K}N$ scattering data allows the $\pi\Lambda\Sigma$ and $\pi\Sigma\Sigma$ couplings to be determined. It is suggested that this method of determination is incapable of yielding reliable numerical results at present. (auth)

42653 CALCULATION OF S-WAVE PION–PION PHASE SHIFTS FROM THE P-WAVE. Bowcock, J. E.; John, G. (Univ., Tuebingen, Ger.). Nucl. Phys., B11: 659-66(1969).

A method is developed which allows the analytic continuation of a function from the right-hand physical cut to the left-hand unphysical cut, independent of any particular analytic form. This is then applied to the continuation of the pion-pion P-wave on which information is available from electron-positron annihilation. Crossing symmetry then lead to the S-wave amplitudes which show a broad resonance in the I = 0 state at approximately the same energy as the rho meson. (auth)

42654 CHIRAL SYMMETRY AND LINEAR TRAJECTORIES. Brout, R.; Englert, F.; Truffin, C. (Univ. Libre, Brussels). Phys. Lett., 29B: 590-2(Aug. 4, 1969).

It is shown that chiral symmetry ($\mu_\pi^2 = 0$), absence of I = 2 resonances and single particle saturation imply that the π and ρ trajectories rise linearly and differ in intercept by $1/2$. (auth)

42655 DALITZ PLOT ANALYSIS FOR THE X^0 DECAYING INTO $\eta\pi^+\pi^-$. Dufey, J. P. (Eidgenoessische Technische Hochschule, Zurich); Gobbi, B.; Pouchon, M. A.; Cnops, A. M.; Finocchiaro, G.; Lassale, J. C.; Mittner, P.; Mueller, A. Phys. Lett., 29B: 605-8(Aug. 4, 1969).

The Dalitz plot for the decay $X^0 \to \pi^+\pi^-\eta$ was analyzed and shows a dependence on $\pi\pi$ mass. Various quantum numbers assignments are discussed. (auth)

42656 RECENT RESULTS ON PION–PION INTERACTIONS OBTAINED FROM PION PRODUCTION EXPERIMENTS. Gutay, L. J. (Purdue Univ., Lafayette, Ind.); Meiere, F. T.; Carmony, D. D.; Loeffler, F. J.; Csonka, P. L. Nucl. Phys., B12: 31-71 (1969).

The theoretical methods used to extract $\pi\pi$ phase shifts from inelastic πN scattering experiments are presented in detail. A critical review of the major analyses which study $\pi\pi$ interactions in the ρ region is given. The specific points on which the various methods differ, as well as the theoretical assumptions which are common to all, are presented. Finally, an attempt is made to extract from all experiments a consistent set of S-wave phase shifts in the region 600 MeV to 1000 MeV. (auth)

42657 VENEZIANO'S MODEL FOR PSEUDOSCALAR–PSEUDOSCALAR SCATTERING, FACTORIZATION, AND THE NONET ANSATZ. Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 41: 1555-65(June 1969).

Crossing-symmetric, Regge behaved amplitudes of the Veneziano type are constructed for $P_8 - P_8$ scattering, where P_8 denotes the pseudoscalar meson octet. Factorization of the parent and the first (odd) daughter Regge trajectories is investigated in detail. Several relations for the $V_9P_8P_8$ and the $T_9P_8P_8$ coupling constants which are equivalent to or consistent with the SU(3) symmetry and Okubo's nonet ansatz are obtained, where V_9 and T_9 denote the vector and the tensor meson nonets, respectively. Positive definiteness of the square of the first daughter-P_8-P_8 coupling constant leads to inequalities for the trajectories or the masses which are well satisfied by experiment. Factorization condition for the first daughter trajectories leads to trajectory or mass relations which are well satisfied experimentally. In particular the requirement of the universality for the parent and the first daughter ρ couplings leads to the broken SU(6) mass relations which have been obtained by Kawarabayashi, Kitakado and Yabuki using Adler's PCAC consistency conditions applied to the Veneziano model. Consequences from the requirement of the PCAC conditions on the η-meson processes are discussed briefly. (auth)

42658 EFFECTIVE LAGRANGIANS AND FIELD ALGEBRAS WITH CHIRAL SYMMETRY. Gasiorowicz, S. (Univ. of Minnesota, Minneapolis. Deutsches Elektronen Synchrotron, Hamburg); Geffen, D. A. Contract AT(11-1)-1764. Rev. Mod. Phys., 41: 531-73(July 1969).

Recent developments of effective Lagrangians and field algebras as means of treating chiral symmetry and partially conserved axial current (PCAC) for the study of elementary particle physics are reviewed. The techniques employed are developed in considerable detail. As examples, the concentration is primarily on spin 0 and 1, linear and nonlinear realizations of SU(2) × SU(2) and SU(3) × SU(3) and some of the significant predictions of the theory are derived. An extensive discussion of an effective Lagrangian with nonets of real scalar, pseudoscalar, vector, and axial-vector mesons that illustrate the problems of broken SU(3) × SU(3) is given. (auth)

42659 REGGE-POLE INELASTICITY, PARTIAL WAVES, AND A MODEL FOR THE S MATRIX. Childers, Robert W. (Univ. of Tennessee, Knoxville); Martin, Arthur W. Phys. Rev., 182: 1762-9(June 25, 1969).

The asymptotic behavior of partial-wave amplitudes in the physical region, as deduced from Regge theory, is used to calculate the inelasticity functions and partial-wave driving forces at large energies for pion-pion and pion-nucleon scattering. The results provide useful information for N/D calculations. The Regge-pole inelasticity functions possess a special property; they are asymptotically (in energy) independent of l. This implies that inelastic unitarity at large energies closely resembles the elastic-unitarity condition and suggests an approximate model for the two-body S matrix. The model incorporates Mandelstam analyticity, inelastic unitarity, and crossing symmetry, and leads to integral equations for the absorptive parts of the invariant amplitudes. (auth)

42660 MESON TOWERS AND THE ABSENCE OF BACKWARD PEAKS. Barger, V. (Univ. of Wisconsin, Madison); Cline, D. Contract AT(11-1)-881. Phys. Rev., 182: 1849-52(June 25, 1969).

The absence of backward peaks in $\pi^+\pi^-$, π^+K^-, K^+K^-, and $\bar{N}N$ elastic scattering is speculatively associated with the existence of direct-channel exchange-degenerate towers of meson resonances. Experimental evidence for meson towers associated with a (ω,ρ,f^0,A_2) master trajectory is presented. Consequences of a pure resonance picture of the low-energy $\bar{N}N$ elastic amplitude are explored. (auth)

42661 SPLIT PEAKS AND EXOTIC RESONANCES. Arnold, Richard C. (Argonne National Lab., Ill.); Uretsky, J. L. Phys. Rev. Lett., 23: 444-6(Aug. 25, 1969).

The existence of exotic mesons is inferred from the apparent splitting of the A_2 peak. (auth)

42662 EXPERIMENTAL TEST OF WEINBERG'S OFF-MASS-SHELL DEPENDENCE OF THE $\pi\pi$ SCATTERING AMPLITUDE. Gutay, L. J.; Meiere, F. T.; Scharenguivel, J. H. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 23: 431-3(Aug. 25, 1969).

The off-mass-shell behavior of the S-wave $\pi\pi$ amplitude predicted by Weinberg implies that the S-P–wave interference interference term in pion production vanishes for certain values of momentum transfer and $\pi\pi$ effective mass. Such behavior is shown to be consistent with experiment. The analysis determines the ratio of scattering lengths and the isospin content of the sigma commutator of current algebra. (auth)

42663 FINITE-ENERGY SUM RULES AND THE PROCESS $0^- + 0^- \to 0^- + 0^-$. Schmid, Christoph; Yellin, Joel (Univ. of California, Berkeley). Phys. Rev., 182: 1449-58(June 25, 1969).

Pseudoscalar-pseudoscalar meson elastic scattering is discussed, using finite-energy sum rules. Algebraic properties of the resulting equation are derived, and numerical values are given for the $1^-0^-0^-$ and $2^+0^-0^-$ couplings, computed using the physical 0^-, 1^-, and 2^+ masses. (auth)

42664 VENEZIANO MODEL FOR $\pi\pi \rightarrow \pi S$, WHERE S HAS ARBITRARY SPIN AND PARITY. Goebel, C. J. (Univ. of Wisconsin, Madison); Blackmon, Maurice L.; Wali, Kameshwar C. Contract AT(11-1)-881. Phys. Rev., 182: 1487-92(June 25, 1969).

The Veneziano model is applied to the reaction $\pi\pi \rightarrow \pi S$, where S is any particle spin S, isospin 0 or 1. For particles with natural parity, $P = (-1)^s$, it is required that the amplitude not be coupled to any odd daughters. This fixes the relative magnitudes of the helicity amplitudes and constrains the particles $S(\omega, A_2, \cdots)$ to lie on a trajectory which is parallel to the degenerate ρ and f trajectories. For particles with unnatural parity, $P = -(-1)^s$, it is demanded that the amplitude satisfy the Adler consistency condition. This gives mass restrictions on the sequence of particles $\pi, A_1, \cdots$. (auth)

42665 SUM RULES, THE SU(2) ⊗ SU(2) CHARGE ALGEBRA AND SCATTERING LENGTHS FOR $\pi + \pi \rightarrow \pi + \pi$. Yellin, Joel (Univ. of California, Berkeley). Phys. Rev., 182: 1482-6(June 25, 1969).

The Veneziano model for $\pi\pi$ scattering is discussed in connection with the hypothesis of partially conserved axial-vector current, the SU(2) ⊗ SU(2) charge algebra, the scattering-length ratio a_0/a_2, and the finite-energy sum rules of Dolen, Horn, and Schmid. Following Dashen and Weinstein, and abstracting from the model, it is proposed that SU(2) ⊗ SU(2) is a symmetry of the system, and that the strength of the symmetry-breaking interaction is proportional to the deviation of the intercept of the ρ trajectory from ½. (auth)

42666 MASS OF THE SCALAR NONET. Pancheri-Srivastava, G.; Srivastava, Yogendra (Northeastern Univ., Boston). Phys. Rev., 182: 1602-5(June 25, 1969).

The mass of the scalar ($J^P = 0^+$) nonet is calculated using finite-energy sum rules. The same results are obtained upon using the Veneziano model. The results are $\sigma(I^G = 0^+$, 770 MeV), singlet $\eta_0^+(I^G = 0^+$, 1020 MeV); $\delta(I^G = 1^-$, 930 MeV) and $\kappa(I = ½$, 1090 MeV). These results are in good agreement with their phenomenologically inferred values. (auth)

42667 PION GAUGE INVARIANCE AND LOW-ENERGY THEOREMS. Kramer, G.; Palmer, W. F. (Argonne National Lab., Ill.). Phys. Rev., 182: 1492-1506(June 25, 1969).

Zero-mass pion theories invariant under c-number translations ("chiral transformations") of the pion field are studied in a general framework. The operator which induces the chiral transformation is defined in Fock space (in which it is not unitary) and in von Neumann's infinite-tensor-product space (in which it is unitary). The transformed (noninvariant) Fock-space vacuum is recognized as a coherent state in the tensor-product space. The generator of the chiral transformation—a constant of the motion in gauge-invariant theories—is diagonalized, and its eigenvectors, the "chiral states," are employed in one of two derivations of low-energy theorem for zero-mass pion emission and absorption, assuming gauge invariance of the theory. The other method of derivation is also used to rederive the electromagnetic gauge conditions. Then Lagrangian models (gradient-coupling, c-number, and operator theory) are studied in which the invariance is realized provided the current is suitably restricted. Implications of the low-energy theorem are checked (exactly for the c-number theory, in lowest-order perturbation theory for the operator theory). A larger class of models is then considered in which, it is shown, the complicated set of transformations under which the Lagrangian is invariant reduce, by virtue of the field equations and the asymptotic condition, to a simple pion translation when expressed in terms of the asymptotic fields, and hence obey the supposition of our theorem, which we again check in lowest-order perturbation theory. (auth)

42668 HADRONIC MASS QUANTUM. Freund, Peter G. O. (Argonne National Lab., Ill.). Phys. Rev. Lett., 23: 449-52 (Aug. 25, 1969).

On the basis of chiral dual dynamics it is shown that the square of the mass of any nonexotic strange or nonstrange meson or baryon of nonvanishing isospin (with the possible exception of I = 1 baryons) must be an integer multiple of the "quantum" $½m_\rho^2$. It is found that the strength of SU(3) breaking can only take certain discrete values. (auth)

42669 MASS OF THE κ MESON AND THE RELATIVE SIGN OF F_K AND F_π FROM BROKEN CHIRAL SYMMETRY. Acharya, R.; Bebie, H. (Univ., Bern). Phys. Rev., 182: 1916-17(June 25, 1969).

The Glashow-Weinberg analysis of broken chiral symmetry is reexamined in the light of the recently established equality $F_K^2 = F_\pi^2$. It is shown that if the pole-dominance hypothesis for J = 0 and J = 1 mesons is valid, then (a) F_K and F_π must have opposite signs and (b) the κ meson must lie above the $K\pi$ threshold. (auth)

42670 SOME COMMENTS ON UNITARITY CORRECTIONS TO CURRENT-ALGEBRA RESULTS. Bhargava, S. C. (Univ. of Delhi). Phys. Rev., 182: 1920-1(June 25, 1969).

Some further comments on unitarity corrections to current-algebra results are made. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 42007, 42656, 42726, and 42778.

42671 (ITF-69-28) INELASTIC HADRON SCATTERING IN THE QUARK MODEL FACTORIZABILITY HYPOTHESES. Kobushkin, A. P.; Kukhtin, V. V.; Naumov, A. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 8p. (In Russian). (CONF-690417-20). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

On the basis of the factorizability hypothesis of the amplitude of the scattering processes the inelastic two-particle reactions are investigated in the quark model with the spin structure of the hadron wave functions to be taken into account. The relations obtained for differential cross sections are compared with experiment. (auth)

42672 (UCRL-19231) PARTIAL-WAVE ANALYSIS OF K^+p ELASTIC SCATTERING. Hall, B. H.; Bland, R. W.; Goldhaber, G.; Trilling, G. H. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1969. Contract W-7405-eng-48. 10p. (CONF-690608-6). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Sweden.

Revised results for partial-wave solutions for $K^+ + p$ elastic scattering are given for 864 and 969 MeV/c, based on final data; and several solutions at 1207 MeV/c are given which were obtained using new polarization data. It is concluded that up to 1200 MeV/c there are no large inelastic resonances in the K^+ p channel. The data are consistent with a smooth slow variation of all partial-wave amplitudes from threshold to 1200 MeV/c with a consistently large negative S-wave phase shift agreeing reasonably well with a previous nonresonant solution. (J.F.P.)

42673 POLARIZATION AND SPIN-ROTATION PREDICTIONS. FROM A NEW REGGE FIT TO πN SCATTERING. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881. Phys. Lett., 29B: 503-4(July 21, 1969). (COO-881-237).

Predictions for πN polarization and spin-rotation in the 2-6 GeV/c momentum range are made from a new fit to πN scattering and continuous momentum sum rule data with P, P′, P″, ρ and ρ' Regge poles. (auth)

42674 POLARIZATION EXPERIMENTS AND THE ADDITIVITY ASSUMPTION OF THE QUARK MODEL. Kotanski, A. (Jagellonian Univ., Krakow); Zalewski, K. Phys. Lett., 29B: 596-7 (Aug. 4, 1969).

It is shown how experiments with particles polarized in the reaction plane can be used to resolve an ambiguity in the interpretation of the additivity assumption, basic for the quark model. (auth)

42675 MESON DOMINANCE OF THE WEAK NUCLEON AMPLITUDE. Micu, M. (Inst. for Atomic Physics, Bucharest). Nucl. Phys., B12: 239-44(1969).

Using the idea that the weak currents are dominated by π, ρ and A_1 mesons some relations are obtained between amplitudes of the nucleon-(π or A_1)-meson scattering. These relations give informations about the parameters of the nucleon (π, ρ and A_1) meson coupling. The coupling parameters obtained in this way are exactly the same as those used in chiral invariant Lagrangian theory. (auth)

42676 CALCULATION OF STRANGE PARTICLE COUPLING CONSTANTS. Perrin, R. (Univ. of Durham, Eng.); Woolcock, W. S. Nucl. Phys., B12: 26-30(1969).

Using the dispersion relations for the K^+p forward elastic scattering amplitudes, the combination of coupling constants $(g^2_{K^-p\Lambda} + 0.847\, g^2_{K^-p\Sigma})$ was recalculated using improved data. The result is substantially lower than the minimum allowed by SU(3) invariance. (auth)

42677 THE DOUBLE PERIPHERAL MODEL AND THE REACTION $K^-p \rightarrow K^{*-}\pi^+n$ AT 6 AND 10 GeV/c. Hunt, A. P. (Imperial Coll. of Science and Tech., London); Schonfelder, J. L. Nucl. Phys., B12: 15-25(1969).

Detailed calculations for the reaction $K^-p \rightarrow K^{*-}\pi^+n$ at 6 and 10 GeV/c are presented. The non-resonant background, which accounts for most of the cross section, is assumed to be due to double peripheral exchange mechanisms. The relative strengths of the couplings for the various exchanges involved are fixed by using U(6,6) symmetry. "Off-shell" and "absorption" effects are included in an approximate way by the use of phenomenological form factors. A contribution from the K*(1420) resonance is included explicitly and the production and decay amplitude for this process is allowed to interfere with the background. Encouraging agreement with experiment is found for all the relevant one dimensional distributions. (auth)

42678 SINGLE PION PRODUCTION IN LOW-ENERGY PION–NUCLEON SCATTERING AND CHIRAL DYNAMICS. Hattori, Chuichiro; Kobayashi, Makoto; Kondo, Hiroki; Maskawa, Toshihide (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1515-32(June 1969).

Single pion production in low energy πN scattering is discussed by means of partially chiral invariant Lagrangian of pion, nucleon and Δ_{33} isobar system. The theory gives good fits for the experimental data in the reaction $\pi^-p \rightarrow \pi^+\pi^-n$ below the Δ_{33} threshold. The enhancement for the large $\pi^+\pi^-$ invariant mass value is reproduced fairly well. Furthermore, when use is made of the coupling constant of π^4 interaction determined from the reaction $\pi^-p \rightarrow \pi^+\pi^-n$, it is shown that good fits are also obtained for the phase shifts of $\pi\pi$ scattering in the S-wave I = 0 and S-wave I = 2 states up to 700 MeV in $\pi\pi$ system. The energy dependence of the phase shift is deduced from the peculiar term of chiral dynamics. The results as a whole suggest that chiral dynamics describes some aspects of hadron dynamics even in a relatively high energy region. (auth)

42679 THE NUCLEON AND THE ROPER RESONANCE. Bhargava, S. C.; Patil, Sharashchandra H. (Univ. of Delhi). Phys. Rev., 182: 1711-13(June 25, 1969).

A coupled two-channel bootstrap calculation is performed for the static system of πN and $\pi\pi$N in the positive-parity I = J = $\frac{1}{2}$ state. For the $\pi\pi$N state, an analysis of Ball et al., is used which reduces the three-particle system to a two-particle system with a modified phase space. The calculations are made using the N/D method and the static Bethe–Salpeter equation. The results are in reasonable agreement with the experimental positions and partial widths, and imply that the Roper resonance is primarily a $\pi\pi$N resonance. (auth)

42680 CONTINUOUS-MOMENT SUM RULES AND ABSORPTIVE REGGE CUTS IN THE PROCESS $\pi^-p \rightarrow \eta n$. Botke, John; Fulco, Jose R. (Univ. of California, Santa Barbara). Phys. Rev., 182: 1837-43(June 25, 1969).

The Regge-pole model with absorptive corrections is applied together with the continuous-moment sum rules (CMSR) to the process $\pi^-p \rightarrow \eta n$. It is found that a good fit to both the low- and high-energy scattering cross sections and the polarization at several values of the momentum transfer t can be obtained by including Regge absorptive cuts and three Regge poles corresponding to the A_{2H}(1315), the π_N(1016), and possibly a pole with the same trajectory parameters as the pion conspirator (π_c) found in previous studies of pion photoproduction. (auth)

42681 πN SCATTERING IN THE VIRASORO MODEL. Hara, Yasuo (Tokyo Univ. of Education). Phys. Rev., 182: 1906-9(June 25, 1969).

A representation of the πN scattering amplitude that contains Regge behavior, crossing symmetry, and analyticity is given by making use of the Virasoro model. (auth)

42682 DECK EFFECT WITH K EXCHANGE. Lai, Kwan Wu (Brookhaven National Lab., Upton, N. Y.); Shpiz, Joseph M. Phys. Rev., 182: 1536-8(June 25, 1969).

It is shown that the nature of the vertex function for $\bar{K}N \rightarrow \Lambda\pi$ favors a kinematical configuration of the $\rho\pi\Lambda$ in $\bar{K}N \rightarrow \Lambda\pi\rho$ which effectively competes with the kinematical configuration responsible for the Deck effect, and substantially flattens the low-mass enhancement. This reaction is thus a far more suitable one in which to verify and study the $A_1(\rho\pi)$ enhancement. These results should also be applicable to a study of the K*(1300) in the reaction $\pi N \rightarrow \Lambda K^*(890)\pi$. (auth)

42683 SINGLE- AND DOUBLE-PION PRODUCTION BY ONE-PION EXCHANGE AND A COMPARISON WITH EXPERIMENTAL DATA BETWEEN 1.6 AND 20 GeV/c. Wolf, Guenter (Stanford Univ., Calif.). Phys. Rev., 182: 1538-60(June 25, 1969).

A detailed comparison was made between predictions of elementary one-pion exchange (OPE) and existing experimental data. The Benecke–Dürr (BD) parametrization was used to describe the vertex functions. The BD parametrization has one free parameter R for each vertex. The momentum transfer (t) distributions as measured between 1.6 and 10 GeV/c for the reactions $\bar{p}p \rightarrow \bar{\Delta}^{--}\Delta^{++}[\Delta \equiv \Delta(1236)]$, $pp \rightarrow \Delta^{++}n$, $\pi^+p \rightarrow \Delta^{++}\rho^0$, and $\pi^-p \rightarrow n\rho^0$ were used to fit the parameters $R_{\Delta N\pi}$, $R_{NN\pi}$, and $R_{\rho\pi\pi}$ which describe the NNπ, ΔNπ, and $\rho\pi\pi$ vertices. With the three-parameter fit an excellent description of the data is achieved for $|t| < 1$ GeV^2 at all energies, a result which independently of any model demonstrates that the energy dependence of these reactions is that of elementary OPE. From the R parameters, values for various pionic rms radii were deduced: $\langle r_{NN\pi}{}^2\rangle^{1/2} = 1.06 \pm 0.04$ F, $\langle r_{\Delta N\pi}{}^2\rangle^{1/2} = 0.86 \pm 0.02$ F, and $\langle r_{\rho\pi\pi}{}^2\rangle^{1/2} = 0.65 \pm 0.05$ F. The NNπ and ΔNπ values agree with results from πN and ep scattering. As a further consistency check, the BD parametrization was used to describe the ($\frac{3}{2}$, $\frac{3}{2}$) pion nucleon phase shift δ_{33} in the neighborhood of the Δ. A good fit to the δ_{33} data is found. The value of $R_{\Delta N\pi}$ agrees within 20% with that from the fit to the t distributions. The OPE predictions were calculated for the reactions $\pi^{\pm}p \rightarrow p\pi^+\pi^{\pm}\pi^-$ in absolute magnitude and compared with available experimental results on effective-mass and momentum-transfer distributions at beam momenta between 2.1 and 20 GeV/c. In general, the shape of the distributions is quite well reproduced. Bumps which are present in the p2π mass distributions, and which may be taken as evidence for the production of nucleon isobars, can be understood as reflections of the OPE process. The OPE contributions are substantial at all energies; they amount to ~40% near threshold and increase to ~90% at 20 GeV/c, in contrast to the naive expectation that at higher energies the exchange of particles with higher spin will dominate. (auth)

42684 DOUBLE-REGGE-POLE ANALYSIS OF THE REACTION $K^-p \rightarrow K^{*0}(890)\pi^-p$ AT 7.3 GeV/c. Chung, S. U.; Eisner, R. L.; Ball, N. F.; Lueers, D. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 182: 1443-5(June 25, 1969).

The double-Regge-pole model is applied to the final state $K^{*0}(890)\pi^-p$. Reasonable fits to the data are obtained by using the matrix element corresponding to exchange of the pion and Pomeranchukon trajectory. (auth)

42685 QUARK MODEL, MULTIPLE SCATTERING, AND REGGE THEORY. Dean, Nathan W. (Cambridge Univ., Eng.). Phys. Rev., 182: 1695-1710(June 25, 1969).

The quark model for meson-nucleon scattering is treated by means of Glauber theory, using Reggeized quark scattering amplitudes. The multiple-scattering effects are calculated, and numerical estimates of their magnitudes are obtained by fitting the resulting forms to the available data. It is found that the correction terms obtained in this way are generally subtractive and amount to 15% of the total cross sections. They disappear at a rate intimately connected with the shrinking of the diffraction peak; when the latter phenomenon begins to occur, our model predicts that total cross sections will show an increase of several millibarns. The multiple-scattering terms are essentially Regge-cut effects, and therefore may be helpful in explaining the nonvanishing polarization observed in πp charge exchange. Using a simple model of this type, reasonably good fits to all types of pion-nucleon scattering data are obtained including both elastic and charge-exchange polarizations as well as total and differential cross sections. (auth)

42686 FORMALISM FOR PARTIAL-WAVE ANALYSIS OF THE REACTION MESON (0^-) + BARYON ($\frac{1}{2}^+$) → MESON (0^-) + BARYON ($\frac{3}{2}^+$). Brody, A. D. (Stanford Univ., Calif.); Kernan, A. Phys. Rev., 182: 1785-93(June 25, 1969).

The formalism for making a partial-wave analysis of the reactions $\pi + N \rightarrow \Delta\ (1236) + \pi$ and $\bar{K} + N \rightarrow \Sigma\ (1385) + \pi$ is outlined. From such an analysis, the coupling of baryon resonances to these inelastic channels can be determined. The differential cross section, decay distribution for $\Delta \rightarrow N + \pi$, and nucleon polarization are expressed as functions of the S-matrix elements $S_{l'_{3/2},\, l_{1/2}}{}^J(k)$, which connect the initial πN state with orbital angular momentum l, spin J, and c.m. momentum k to the $\Delta\pi$ state with orbital angular momentum l′. (auth)

42687 SUM RULES FOR MESON–BARYON SCATTERING. Prokhvatilov, E. V. Vestn. Leningrad. Univ., No. 4, Ser. Fiz. Khim., No. 1, 52-5(Feb. 1969). (In Russian).

New sum rules for meson-baryon scattering with the use of the information about a real part of the scattering amplitudes are considered. The obtained f/d ratio is close to the well-known $SU_{(6)}$-result. (auth)

42688 PRODUCTION OF RESONANCES IN RESCATTERING MODEL. Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Phys. Rev., 182: 1910-12(June 25, 1969).

The resonance (D) production process A + B → C + D can be regarded as a two-step process A + B → b + d → C + D, where the s-channel particles b and d are put on their mass shells in the rescattering square diagram. The corresponding absorptive part of the amplitude can be calculated by exploiting the pole in the amplitude for the process b + d → C + D. The assumption that the absorptive part dominates than yields a production angular distribution for $N^{*-}(1236)$ and $Y_1^*(1385)$ in agreement with experiment, without any additional assumption regarding the production angle of the particle d. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 42711 and 42983.

42689 (JINR–P1-4536) NEW MEASUREMENTS OF THE ANGULAR DEPENDENCE OF THE DEPOLARIZATION PARAMETER IN 635-MeV pp SCATTERING. Zul'karneev, R. Ya.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The results of new measurements of the D_{pp} parameter at 635 ± 9 MeV are described. For the scattering angles of 12, 15, 18, 21, 27, 32, 41, 49 and 55° (lab. syst.) the values of $D_{pp}(\theta)$ are found to be equal 1.14 ± 0.24; 0.940 ± 0.079; 0.890 ± 0.078; 0.872 ± 0.030; 0.913 ± 0.050; 0.708 ± 0.080; 0.697 ± 0.040; 0.707 ± 0.070; 0.480 ± 0.090, respectively. The results are discussed from the point of view of the M(12) and $SU(12)^*_L$ symmetries. (auth)

42690 (JINR–P2-4509) INTERACTION CROSS SECTIONS OF HIGH ENERGY PARTICLES WITH THE ATOMIC NUCLEI. Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 10p. (In Russian). Dep.

To calculate nuclear cross sections of σ_t, σ_{el}, σ_{in} in the energy region from several hundreds of MeV and more the Glauber theory can be used. For heavy nuclei the theory gives the results not more accurate than for a usual optical model. (auth)

42691 POLARIZATION EFFECTS IN HIGH-ENERGY ELASTIC PROTON–PROTON SCATTERING. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev. Lett., 23: 351-3(Aug. 11, 1969).

A proposal is made to scatter unpolarized protons from a proton target polarized in three mutual directions and to measure the polarization of the recoil proton in the same direction as the target polarization. The directions of polarization are perpendicular to the scattering plane, in the direction of the recoil proton, and orthogonal to the above two. The results of this measurement can be used to differentiate Regge-pole theory from the impact-factor representation. (auth)

42692 POMERANCHON EXCHANGE AND p–p ELASTIC SCATTERING. Greco, M. (CNEN, Frascati, Italy). Phys. Lett., 29B: 505-9(July 21, 1969).

A representation for the Pomeranchon exchange and the multiple scattering corrections is suggested, which contains crossing symmetry, asymptotic Regge behavior, and obeys the duality requirement of a non resonating background. A very good description of the proton-proton elastic scattering is obtained in the diffraction, intermediate and large angle regions. (auth)

42693 REGGE-POLE FORMALISM FOR PIONIC DISINTEGRATION OF DEUTERON. Lee, Huan. Berkeley, Calif., Univ. of California, 1968. 53p.

Thesis.

The reaction $\pi^+ + d \rightarrow p + p$ was investigated within the framework of Regge pole theory. Reggeization of the amplitudes for this process is carried out in detail, and the asymptotic behavior of the helicity amplitudes at zero momentum transfer is discussed. By assuming that the lowest anomalous threshold singularity in the t-channel dominates in the nearby region, the nucleon-deuteron Regge residue is calculated in terms of the pion-nucleon Regge residue. Also discussed are the relations of various low energy models used to study this reaction and its inverse to the Regge pole formalism. (Disser. Abstr.)

42694 ΛN AND ΛΛ INTERACTION AND STRUCTURE OF HYPERNUCLEI. Khrylin, B. A.; Zhukov, M. V. (Inst. of Atomic Energy, Moscow). Phys. Lett., 29B: 538-9(Aug. 4, 1969).

Parameters of ΛN and ΛΛ interactions were found from the binding energies of hypernuclei $^4He_\Lambda$, $^5He_\Lambda$, $^6He_{\Lambda\Lambda}$. A possibility is discussed of multiplet state existence of hypernuclei, which exist due to the proximity of ΛN interactions in singlet and triplet spin states. (auth)

42695 BACKWARD PEAK IN PROTON–DEUTERON ELASTIC SCATTERING AT HIGH ENERGY. Kanada, Hiroyuki (Niigata Univ., Japan); Sakai, Kenji; Yasuno, Masaru. Progr. Theor. Phys. (Kyoto), 41: 1605-6(June 1969).

The energy and momentum transfer dependence in the backward region of proton-deuteron scattering is studied by the impulse approximation, taking into account exchange mechanisms between two protons. Calculated results for the backward angular distribution are compared with experimental data. (L.B.S.)

42696 ON THE EFFECT OF HIGHER π-N RESONANCES ON N–N SCATTERING. Furuichi, Susumu; Sokawa, Tohru (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 1504-14(June 1969).

Effects of higher π-N resonances than $N^*_{33}(1236)$ on nucleon-nucleon scattering are investigated for the uncorrelated 2π-exchange term. The cutoff for momentum transfer at t_{max} is treated as a parameter. It is found that the contribution from these higher resonances is extremely small as a whole, in so far as we take $t_{max} < 25$ (pion mass)^2, due to large cancellation among them in S-wave 2π state. Then, the conclusions for 2π exchange effect, derived by using the CGLN $(N + N^*_{33})$-approximation, have a rather extensive validity provided the practical necessity of introducing the cutoff. (auth)

42697 NEW DATA AND IMPROVEMENTS IN NUCLEON–NUCLEON PHASE PARAMETER ANALYSIS. Seamon, Robert Edward. New Haven, Yale Univ., 1968. 328p.

Thesis.

Multiple energy phase-parameter fits to proton-proton (p-p) and neutron-proton (n-p) scattering data separately and combined are obtained, and tests of long-range charge independence are made. Causality requirements for the energy dependence of uncoupled and coupled phase parameters and the calculation of corrections needed to convert data obtained from proton-deuteron (p-d) scattering to equivalent free n-p measurements, taking into account S-wave final state interactions between the two residual protons in the case of recoil neutron detection are discussed and applied. The possible presence of unknown sources of error in the data is looked into and some data definitely out of line with the general trends are removed. Other improvements over older work include the introduction of new experimental measurements, a more careful joining of the phase parameters to those obtained from low energy data, the use of triple scattering and polarization data at 430 MeV, data lumping into smaller groups, increased accuracy of the one-pion-exchange (OPE) contributions, and the introduction of a graded introduction of the OPE group of phase parameters. The importance of the Coulomb interaction and short-range charge independence violation are investigated as well as that of the n-p data obtained using deuterium targets. It is found that existing data in the energy range 13 to 350 MeV do not distinguish between values of the n-p singlet effective range differing by either 3 or 10% from the corresponding p-p value. Calculations are presented which indicate the relative value of various measurements for improving the knowledge of the p-p and n-p effective ranges which is connected with the question of charge independence of the nucleon-nucleon interaction in the $^1S_0$ state. (Disser. Abstr.)

42698 POTENTIALS IN NUCLEON–NUCLEON SCATTERING. Friedman, Kenneth Alan. New Haven, Yale Univ., 1968. 260p.

Thesis.

Hard and soft core static potential representations of nucleon-nucleon elastic scattering data at energies up through 350 MeV were obtained by fitting quantities concerned with nucleon-nucleon interactions at low energies and the energy dependent phase parameters of the recently completed phenomenological phase-parameter analyses at Yale. Results of analyses of low energy experimental data are discussed. Possible sources of error in the low energy experiments and their interpretation are mentioned. As an example of effects, which may not have been sufficiently considered in the literature, the uncertainties in the interpretation of experimental measurements and in the theory of the liquid mirror determination of the n-p coherent scattering length are discussed. Apparent short range charge independence violation has been partially accounted for by employing the difference between the n-p and p-p singlet scattering lengths and effective ranges. Of the possible values of the n-p singlet effective range, the larger value, which is only three percent smaller than the p-p singlet effective range, appears to be more suited for fitting by a potential. A discussion is given of calculational procedures and formulas, including the calculation of phase parameters from nucleon-nucleon potentials, the methods used below in testing for the existence of bound states of a potential, and the search procedures employed in arriving at the potential fits. The introduction of linear combinations of phenomenological phase parameters for which the statistical uncertainties are uncorrelated and the incorporation of search procedures which had been previously used only in phenomenological phase parameter analyses were useful in adjusting the potentials to experimental nucleon-nucleon elastic scattering data. (Disser. Abstr.)

Particle Invariance Principles and Symmetries

General

42699 MATRIX ELEMENTS OF THE SUPPLEMENTARY SERIES OF UNITARY REPRESENTATIONS OF SL(2,C). Stroem, Staffan (Inst. of Theoretical Physics, Gothenburg, Sweden). Ark. Fys., 38: 373-81(1968).

The matrix elements of a finite transformation in a unitary irreducible representation of SL(2,C) belonging to the supplementary series were determined. The calculations were performed in a realization where the representation space is a direct sum of finite dimensional spaces which are irreducible under the SU(2) subgroup. Both the infinitesimal and the global approach were used, and a number of alternative ways of expressing the matrix elements are given. (auth)

42700 GEMEL SYMMETRY AND SUPERCONVERGENCE RELATIONS. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Menotti, P. Phys. Lett., 29B: 593-5 (Aug. 4, 1969).

It is shown from general principles that the O(4)-amplitudes posses "gemel symmetry." (auth)

42701 SPONTANEOUS SYMMETRY BREAKING MECHANISM OF SU(3) $\otimes$ SU(3). Honerkamp, J. (Univ., Bonn). Nucl. Phys., B12: 227-38(1969).

Models of spontaneous symmetry breakdown of SU(3) $\otimes$ SU(3) are discussed with the method of non-linear realizations and with the method of Kibble. Both approaches are compared in detail and the superiority of the non-linear method is shown. The symmetry breaking mechanism in Sugawara's theory of currents is discussed. (auth)

42702 PHYSICAL BASIS OF COMBINED SYMMETRY THEORIES. Mirman, R. (Long Island Univ., Brooklyn). Progr. Theor. Phys. (Kyoto), 41: 1578-84(June 1969).

The proofs (such as those of O'Raifeartaigh, Jost and Segal) that it is impossible to construct a theory combining the Poincaré and the internal symmetry are analyzed by considering which operators the elementary particles should be considered eigenvectors of. It is found that no elementary particle is an eigenstate of the Hamiltonian (or mass-squared operator) since they are eigenstates of operators which do not commute with the Hamiltonian, and since the elementary particles are single particle states and a Hamiltonian cannot be defined for single particle states. It is concluded that the impossibility theorems have no physical relevance. The objections to Coleman's theorem are also considered. (auth)

42703 PARITY OPERATOR AS A TIME-DEPENDENT OBSERVABLE. Werle, J. (Warsaw Univ.). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 17: 305-8(1969).

A self-consistent phenomenological definition of the parity operator P when applied to a system, which at a certain time $t = t_0$ consists of free noninteracting particles, is given. Also a possible continuation of the parity operator into the interaction region is proposed. For this case the parity operator is time-dependent and can be applied to decays of unstable particles provided that the masses of both stable and unstable free particles are invariant under P. In the same way a time-dependent charge conjugation operator is defined. (J.F.P.)

Applications (Electromagnetic and Weak)

Refer also to abstract 42539.

42704 SPECTRAL FUNCTION SUM RULES IN A BROKEN SU(3) SYMMETRY. Kamal, A. N. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B12: 123-45(1969).

Weinberg's spectral function sum rules were studied in a free quark model with SU(3) breaking à la Gell-Mann, that is, the free quark Lagrangian is split into a SU(3) symmetric kinetic part, a SU(3) singlet leading to nonconservation of axial vector current and a SU(3) octet transforming like the eight-component leading to SU(3) breaking. The second sum rule modifies in this model. Though this particular model was used as a guide to the structure of the sum rules the rules themselves are hopefully of much greater generality. The parameters representing the effect of symmetry breaking were calculated and some applications of these sum rules were investigated. (auth)

42705 CURRENT ALGEBRA APPROACH TO CP VIOLATION. Teeters, William Dale. Iowa City, Iowa, Univ. of Iowa, 1968. 90p.

Thesis.

The isospin transformation properties of the CP-violating weak Hamiltonian are examined using the techniques of current algebra. With these techniques, a relation between ϵ, the mass shift parameter, and ϵ', the parameter characterizing the $|\Delta\vec{I}| = 3/2$ component of $H_w^{(-)}$, is derived. With the additional assumption that $H_w^{(-)}$ transforms irreducibly under SU(2) × SU(2), a value for $|\epsilon|$ in qualitative agreement with the experiment is obtained. In addition, the charge asymmetry in $K_L \rightarrow \pi^+\pi^-\pi^0$ due to CP-violation and the neutron electric dipole moment are calculated. The methods presented are used to analyze the predictions of other models of CP-violation. (Disser. Abstr.)

42706 DUALITY, ABSENCE OF EXOTIC RESONANCES, AND THE $\Delta I = 1/2$ RULE IN NONLEPTONIC DECAYS. Kawarabayashi, Ken; Kitakado, Shinsaku (Kyoto Univ.). Phys. Rev. Lett., 23: 440-1(Aug. 25, 1969).

Based on the current-current theory of weak interactions the $\Delta I = 1/2$ rule for nonleptonic decays is derived from a dynamical mechanism that satisfies duality and the absence of resonances in exotic channels. (auth)

42707 UNIVERSAL CP-NONCONSERVING THEORIES. Zachariasen, F.; Zweig, G. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 182: 1446-8(June 25, 1969).

The assumptions of the normal phenomenological weak-interaction theory are examined, and successively relaxed with a view to listing systematically all theories which are in varying degrees similar to the usual theory. A theory is found, of the current-current form, which is universal in the conventional sense, uses only V-A currents, is capable of yielding CP violation, and is consistent with all existing experimental results. (auth)

Applications (Strong)

Refer also to abstracts 42668, 42704, and 42724.

42708 (ITF-69-41) INTRODUCTION OF RESONANCES INTO CHIRAL U(3) x U(3) DYNAMICS. Havrilik, A. M.; Ilyin, Yu. M.; Sabo, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 7p. (In Russian). (CONF-690417-11). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

Meson and baryon resonances are introduced into the chiral U(3) × U(3) dynamics. Calculated relations among decay probabilities are in a good agreement with experimental data. (auth)

42709 FINITE-COMPONENT FIELD REPRESENTATIONS OF THE CONFORMAL GROUP. Mack, G. (International Centre for Theoretical Physics, Trieste, Italy); Salam, Abdus. Ann. Phys. (N. Y.), 53: 174-202(June 1, 1969).

Work done on realization of broken symmetry under the conformal group of space-time in the framework of finite-component field theory is reviewed. Topics discussed include: most general transformation law of fields over Minkowski space; consistent formulation of an orderly broken conformal symmetry in the framework of Lagrangian field theory; algebra of currents and their divergences; manifestly conformally covariant fields and their couplings. (auth)

42710 PARITY NONCONSERVATION IN THE CAPTURE OF POLARIZED THERMAL NEUTRONS. Warming, Elisabeth (Atomic Energy Commission Research Establishment, Risoe, Denmark). Phys. Lett., 29B: 564-6(Aug. 4, 1969).

The asymmetry in the intensity of γ-radiation following the capture of polarized thermal neutrons in ^{113}Cd was measured with Ge(Li) detectors. The result, $A = (-0.6 \pm 1.8) \times 10^{-4}$, like that previously reported [1], gives no evidence for a nonzero effect. (auth)

42711 O(3,1) SYMMETRY AND pp ELASTIC SCATTERING. Samiullah, M. (Osmania Univ., Hyderabad, India); Rao, A. Srinivas. Nucl. Phys., B12: 119-22(1969).

The high-energy behavior of the pp elastic scattering is analyzed within the context of the O(3,1) symmetry formalism. Reasonable fits to the differential cross section and the polarization data are obtained if the dominant amplitudes are chosen to be $\langle \frac{1}{2}\frac{1}{2}|T|\frac{1}{2}\frac{1}{2}\rangle$ and $\langle \frac{1}{2}\frac{1}{2}|T|\frac{1}{2}-\frac{1}{2}\rangle$ for the exchanged particles P, P′ and ω. (auth)

42712 $K^{*+} \rightarrow K^+\pi\pi$ DECAY IN BROKEN SU(3). Costanzi, Frank A. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 182: 1571-4(June 25, 1969).

An effective Lagrangian for pseudoscalar, vector, and axial-vector mesons is used to calculate the $K^{*+} \rightarrow K\pi\pi$ decay rate. It is shown that the octet broken-SU(3) PVV interaction generally increases the calculated $K^{*+} \rightarrow K\pi\pi$ rate over that of the symmetric limit. Experimental determination of the exact rate would allow fixing of parameters in this broken SU(3) scheme, which as yet have been determined by measured decay rates only to be within a range. (auth)

42713 FINE STRUCTURE IN THE MESON SPECTRUM. Boehm, A. (Univ. of Texas, Austin). Phys. Rev. Lett., 23: 436-40(Aug. 25, 1969).

The predictions of an algebraic model are compared with the experimental meson mass spectrum. (auth)

Field Theories

General

42714 (JINR-P2-4605) VELOCITY OF SIGNAL PROPAGATION AND SPACE-TIME METRIC IN NONLINEAR ELECTRODYNAMIC. Duc, Dao Vong; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 21p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is shown that in the nonlinear electrodynamics the propagation velocity of a perturbation which does not depend essentially on the time variable, and which can be considered as a signal, depends in the external field on the density of the field, it is also shown that this velocity can exceed that of the light in vacuum. Consequently, in the external field the ordering (in time) of the emission and the absorption of the signal can depend on the reference system of the conventional formulas of Lorentz transformations. A possibility of overcoming the difficulty by the introduction of a time-depending space-time metric or by the introduction of a new selection principle that would enable one to exclude nonlinear Lagrangians admitting "superlight" signals is discussed. (auth)

42715 GENERAL GEOMETRODYNAMICS: THIRD CLASS. Dubey, R. S. D.; Mishra, R. S. (Univ. of Allahabad, India). Tensor, 18: 309-14(1967).

Einstein–Maxwell field equations were considered in the case of a null electromagnetic field. A set of necessary and sufficient conditions were obtained in terms of the eigenvalues of the contracted curvature tensor so as to admit of even negative mass and negative pressure. The significance of the eigenvalue which leads to the time-like eigen vector of R_{μ}^{λ} was stressed. (auth)

Quantum Field Theory

Refer also to abstracts 42606, 42618–42620, 42667, and 42709.

42716 (IS-2085) TWO PARTICLE QUANTUM ELECTRODYNAMICS. Hammer, C. L.; Moroi, D. S. (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 11p. Dep. CFSTI.

A discussion is given of preliminary results of a field theory based on the spin $\frac{1}{2}$ specialization of a recent manifestly covariant theory for arbitrary spin and mass. The field theory contains all the results of quantum electrodynamics including the μ-meson diagrams. The mass renormalization, which is finite in lowest order, may be finite to all orders. (auth)

42717 SECOND QUANTIZATION OF SCALAR FIELDS IN DE SITTER SPACE-TIME. Castagnino, Mario. Compt. Rend., Ser. A, 268: 1157-60(May 12, 1969). (In French).

A calculation of the commutators of real scalar fields in De Sitter space–time is performed which permits the creation and annihilation operators to be defined. There is a coincidence of these commutators with the difference of elementary particles (that is to say with the previously introduced commutators). (tr-auth)

42718 RENORMALIZATION THEORY. Kuo, P. K. (Cornell Univ., Ithaca, N. Y. Massachusetts Inst. of Tech., Cambridge); Yennie, D. R. Contract AT(30-1)2098. Ann. Phys. (N. Y.), 51: 496-560(Feb. 15, 1969).

Standard renormalization theory is presented with the help of a new technique for handling the subtractions. Briefly, the approach used is to replace the subtraction of terms from the Feynman integrand by an equivalent set of differential and integral operations on the integrals. It is relatively straightforward to show that these operations lead to a unique finite part of every integral. Although the primary concern is with the general analysis of renormalization theory to all orders of the perturbation expansion, the explicit calculation of individual terms in the expansion is straightforward, and certainly not more lengthy than in the usual approach. In this approach, it is a simple matter to demonstrate gauge invariance of the finite amplitudes without explicitly carrying out the integrations; this contrasts with the usual treatment. (auth)

42719 STUDIES IN THE SEMICLASSICAL THEORY OF RADIATION. Young, Ralph Howard. Stanford, Calif., Stanford Univ., 1968. 81p.

Thesis.

Consider a quantum mechanical system which has only a finite number of states and whose Hamiltonian is an oscillatory function of time, for example, a small spin system in an oscillatory electromagnetic field. Because of the periodicity of the Schroedinger equation for the problem, there are solutions which are periodic functions of time multiplied by phase exponentials. These solutions, termed quasiperiodic states, form a set which is complete and orthonormal at all times. Examples are the stationary states of a time-independent Hamiltonian and the rotating-frame stationary states of a rotating-field problem (transformed to the laboratory coordinate frame). The expectation value of a time-independent operator on one of these states oscillates with the same frequency as the Hamiltonian. Resonant behavior takes a particularly simple form when the wavefunction is expanded in terms of quasiperiodic states. As the first step in a search for adiabatic theorems applicable to such problems as the interaction of an atom with a classical radiation field, a nearly exhaustive study of adiabatic theorems applicable to finite dimensional oscillatory systems is carried out. Before demonstrating these theorems, certain mathematical preliminaries must be attended to. If the oscillatory Hamiltonian depends analytically on both time and a parameter, the quasiperiodic states and their associated phase exponentials are shown to be analytic functions of both variables. A well known variational principle for solving the time-dependent Schroedinger equation is discussed and sufficient conditions for its applicability are delineated. An exact formal expression is given for the error in an approximate solution to the time-dependent Schroedinger equation. After these preliminaries, a number of adiabatic theorems are demonstrated. The behavior of quasiperiodic states when an oscillatory Hamiltonian is slowly modulated parallels that of stationary states when a static Hamiltonian is slowly changed. Adiabatic theorems for static Hamiltonians appear as corollaries. The scope of the oscillatory adiabatic theorems is sufficiently broad that these corollaries include some hitherto unknown extensions of the conventional adiabatic theorem for almost static Hamiltonians. The possibility of further extending the oscillatory adiabatic theorems and of applying them to experimental situations is discussed briefly. (Disser. Abstr.)

42720 CLASSICAL ELEMENTARY MEASUREMENT ELECTRODYNAMICS. Leiter, Darryl J. (Boston Coll., Chestnut Hill, Mass.). Ann. Phys. (N. Y.), 51: 561-75(Feb. 15, 1969).

A classical electrodynamic theory is considered in which the operational paradigm of elementary measurement implies that particles and fields are interdependent degrees of freedom in an action principle associated with the "elementary measurement," and are not elementary in themselves. In this model Maxwell's equations, with an empirically chosen Green function, are identities associated with each charged particle current in the elementary interaction. Making the action stationary with respect to the interacting degrees of freedom gives the equations of motion of the measurement. These are shown to be equivalent to those of the "action-at-a-distance" electrodynamics of Wheeler and Feynman, with the distinct advantage that no "complete absorber" assumption is ever needed. The difficulties associated with infinite self-energies and mass renormalization are absent from this theory and a consistent set of energy-momentum and angular-momentum conservation laws follows from the associated energy-momentum tensor. The mechanism of "measurement" radiation is discussed and is shown to predict similar results as that of Maxwell–Lorentz electrodynamics. (auth)

42721 MAGNETIC CHARGE QUANTIZATION AND ANGULAR MOMENTUM. Lipkin, H. J. (Weizmann Inst. of Science, Rehovot, Israel); Weisberger, W. I.; Peshkin, M. Ann. Phys. (N. Y.), 53: 203-14(June 1, 1969).

The quantum mechanical problem of an electric charge moving in the field of a magnetic charge is discussed and solved by algebraic methods which exhibit the direct relation between charge quantization and angular momentum. Commutation relations which lead to the Lorentz force equation are assumed. The operators are realized by constructing the irreducible representations of the three-dimensional Euclidean group in an angular-momentum basis.

The Dirac quantization formula for the charges is obtained as a necessary and sufficient condition for the realization of all the observables. The construction proceeds by simple angular-momentum coupling calculations without resort to singular strings in x space. It is emphasized that the charge quantization does not follow from the operator equations of motion and rotation invariance alone. This treatment, like all previous ones, uses additional assumptions that may not be physically inescapable. (auth)

42722 ON THE BEHAVIOR OF $\int \tilde{A}(\bar{p},p_0)\,\tilde{\varphi}(p_0)\,dp_0$ for $\tilde{\varphi} \in S$ IN AXIOMATIC FIELD THEORY. Kolm, A. Ark. Fys., 38: 353-62(1968).

The averaging of the Fourier transformed field $\tilde{A}(p)$ over its energy variable p_0 is considered. It is proved that for Ψ, Φ belonging to the set D of the Hilbert space a nontrivial part of the matrix element $(\Psi, \int \tilde{A}^n(p_1, \ldots p_n)\,\tilde{\varphi}(p_{10}, \ldots p_{n0})\,dp_{10} \ldots dp_{n0}\,\Phi)$ is an element in S $(\bar{p}_1, \ldots \bar{p}_n)$ if $\tilde{\varphi}$ belongs to $S(p_{10}, \ldots p_{n0})$. (auth)

42723 KVANTOVAYA ELEKTRODINAMIKA. IZDANIE TRET'E PERERABOTANNOE. (Quantum Electrodynamics. Improved Third Edition). Akhiezer, A. I.; Berestetskii, V. B. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1969. 624p.

Data on electromagnetic properties of hadrons, a double logarithmic asymptotics method, and dispersion equations for resolving problems in quantum electrodynamics are presented. The formalism of the photon quantum mechanics theory is covered including the photon wave function, the two-photon system and quantization of the electromagnetic field. Relativistic electron quantum mechanics with Dirac equations, free electrons, electron motion in an external field, electron scattering, and quantization of the electron-positron field are discussed. Electromagnetic interactions are dealt with including quantum electrodynamics equations, probabilities and effective cross sections, diagrams of the scattering matrix, Green's functions for interacting fields, mass and electron charge renormalization. The basic electrodynamic phenomena, photon radiation and scattering, bremsstrahlung, long-wave photons annihilation of electron-positron pains scattering of electron by hadrons and electron-nuclear interactions are covered. Also discussed are radiation corrections for Green functions and vertex functions, modification for the Coulomb law, corrections for cross sections of electron scattering in an external field and Compton scattering, pair formation and annihilation, bremsstrahlung, nonlinear vacuum electrodynamics, photon scattering in a Coulomb field, and the dispersion method for calculation of radioactive correlations. (160 references) (R.V.J.)

42724 ON THE RATIO OF WAVE FUNCTION RENORMALIZATION CONSTANTS OF π AND K MESONS. Acharya, R. (Univ., Bern). Helv. Phys. Acta, 42: 766-70(Aug. 15, 1969).

The validity of Khuri's conjecture on the ratio of the wave function renormalization constants of π and K mesons is investigated within the framework of asymptotic SU(3) symmetry. It is shown that the result holds only if certain strong asymptotic conditions are satisfied. These asymptotic requirements also lead to the degeneracy of A_1 and K_A masses under the pole dominance hypothesis for spin one spectral functions. (auth)

42725 DETERMINATION OF e/h, USING MACROSCOPIC QUANTUM PHASE COHERENCE IN SUPERCONDUCTORS: IMPLICATIONS FOR QUANTUM ELECTRODYNAMICS AND THE FUNDAMENTAL PHYSICAL CONSTANTS. Taylor, B. N. (RCA Labs., Princeton, N. J.); Parker, W. H.; Langenberg, D. N. Rev. Mod. Phys., 41: 375-496(July 1969).

The implications of the new determination of e/h using the ac Josephson effect in superconductors for both quantum electrodynamics (QED) and knowledge of the fundamental physical constants are analyzed in detail. The implications for QED are investigated by first deriving a value of the fine structure constant α from experimental input data which do not require the use of QED theory for their analysis. These include the Josephson-effect value of e/h, the Faraday constant, the gyromagnetic ratio of the proton, the magnetic moment of the proton in units of the nuclear magneton, the ratio of the ampere as maintained by the United States National Bureau of Standards to the absolute ampere, and certain accurately known auxiliary constants. This is done by critically reevaluating all of the experimental data presently available on these quantities and applying the standard techniques of a least squares adjustment, including tests for incompatibility. The value of α so obtained is then used to evaluate the theoretical expressions for the Lamb shift and fine structure splitting in hydrogen, deuterium, and ionized helium, the hyperfine splitting in hydrogen, muonium, and positronium, and the anomalous magnetic moment of the electron and muon. These theoretical values are compared with critically reexamined experimental values, thus providing a test of QED in which a priori information from QED itself is not essential. The consequences of the new measurement of e/h for present knowledge of the fundamental physical constants are demonstrated by deriving new "best" values for the fundamental constants from a critically selected subset of all the available data. In addition to providing a consistent set of constants, this analysis focuses attention on areas in which there remain important questions which require clarification. The experimental and theoretical work necessary for the resolution of these questions is discussed, with emphasis on ways in which the study of quantum phase coherence effects in low temperature superfluid systems can make significant contributions. (auth)

42726 FUNCTIONAL METHODS AND THE INFRARED PROBLEM. Godfrey, John Stuart. New Haven, Yale Univ., 1968. 281p. Thesis.

The problem of calculating scattering cross sections in quantum electrodynamics is studied, with the photon mass maintained at zero at all states of the calculation; the principal problem that is overcome is the infrared divergence of the wave function renormalization constant. The theory of a quantized Coulomb-gauge vector potential interacting with an external current is examined, using Glauber's coherent radiation states. Turning to quantum electrodynamics, a closed formal solution is developed for the matrix elements of time-ordered products of field operators between coherent states; this solution employs functional calculus. An attempt is made to construct the photon cloud around a spatially localized electron, by suitable choice of coherent radiation states. No completely satisfactory construction was found. A new method of calculating cross sections was found, and is illustrated in the case of potential scattering. The life of the electron is regarded as consisting of a series of macroscopically separated collision events, of which just one is studied experimentally. The matrix element for such a process is written down and summed over radiation states. They are expressed as the product of two equal factors, and one factor is associated with each event. This factorization replaces the usual device of wave function renormalization. One obtains a gauge-invariant, infrared convergent expression for the transition probability for a given event; no difference is found between the transition probability obtained this way, and by more usual methods. Radiative corrections to pion-nucleon forward scattering experiments are studied. The lowest-order Feynman diagrams contributing to these corrections are calculated for small momentum transfer; an expression is found for the Coulomb phase shift, which agrees with the well-known result of Bethe, provided the "nuclear radius" is interpreted suitably. (Disser. Abstr.)

42727 QUANTUM MARKOVIAN PROCESS FOR A NON-RELATIVISTIC PARTICLE WITH SPIN. Garczynski, W. (Wroclaw Univ.). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 17: 257-61(1969).

The case of one nonrelativistic particle with internal degrees of freedom is considered. The most general Schroedinger equations for a particle with an arbitrary spin moving in an external field are obtained. As a special case the known Pauli equation for a particle with spin ½ in an external electromagnetic field is derived. (J.F.P.)

42728 QUANTUM MARKOVIAN PROCESS FOR ONE NON-RELATIVISTIC SPINLESS PARTICLE. Garczynski, W. (Wroclaw Univ.). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 17: 251-6(1969).

A continuation of the Dirac and Feynman approach to quantum mechanics is proposed. It is demonstrated that the mathematical concept of a quantum Markovian process is adequate for the needs of this approach. The spinless particle in an external field is considered. (J.F.P.)

42729 SUPERLUMINAL BEHAVIOR, CAUSALITY, AND INSTABILITY. Aharonov, Y.; Komar, A.; Susskind, L. (Yeshiva Univ., New York). Phys. Rev., 182: 1400-3(June 25, 1969).

Two fundamentally different types of superluminal (group velocity > c) behavior are distinguished. One type, called causal, is shown not to conflict with the usual condition that a signal originating in a region is felt only in the forward light cone of that region. This type of mode occurs as small oscillations about an unstable equilibrium configuration of high energy density. The second type of superluminosity, called noncausal, violates the causality conditions of conventional theory. It is shown that the noncausal superluminosity occurs only for field theories which are singular in the sense that there does not exist a unique one-to-one relationship between the momenta and the velocities. The field equations of such theories do not present a good Cauchy problem for arbitrary data on spacelike hyperplanes. They thus lead to ambiguous and/or singular solutions. An interesting feature of our first model is that it leads to tachyonlike behavior without one's having to introduce negative energies. (auth)

42730 NO-INTERACTION THEOREM IN CLASSICAL RELATIVISTIC MECHANICS. Beard, A. N.; Fong, R. (Univ. of Durham, Eng.). Phys. Rev., 182: 1397-9(June 25, 1969).

A slight extension is given of the "no-interaction" theorem, as presented by Van Dam and Wigner, for a closed two-body system in classical relativistic mechanics. The proof here is simple and physical. (auth)

42731 THEORY OF THE HEAVY ELECTRON. Barut, A. O. (International Centre for Theoretical Physics, Trieste, Italy); Cordero, P.; Ghirardi, G. C. Phys. Rev., 182: 1844-8(June 25, 1969).

Quantum electrodynamics with a generalized minimal conserved current of the form $j_\mu = \alpha_1\gamma_\mu + \alpha_2 P_\mu$ is investigated. Fixing the maximum value of α_2 by the anomalous magnetic moment of the electron (muon), an excited state of mass $m' \geq (1 + 4\pi/\alpha)m$ [881 MeV for e'], and of magnetic moment ≤ 3 in units of $1/2m'$, that can decay to the ground state is obtained. The excited state has negative norm, but can be made entirely consistent in the second-quantized theory. The equations are interpreted as those describing a partly "dressed" particle; thus a new form of the perturbation series is suggested. (auth)

42732 THEORY OF HIGH-SPIN FIELDS. Aurilia, A.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Phys. Rev., 182: 1682-94(June 25, 1969).

A general method for the construction of wave functions and wave equations for higher spins is proposed. This method is based on the full use of projection operators, without any use of boosting and without explicit use of auxiliary fields. The wave equations are always expressed in the form of single matrix equations, so that their Lagrangians follow immediately. Then the entire program of quantization of the free fields can follow straightforwardly by using the so-called $d(\partial)$-operator technique which was developed previously. The present method is made up of two steps: The first step is to derive wave equations when the maximum spin is specified; the second step is to derive equations when the spin itself is specified. The technique employed in the first step, when it is applied to many-spinor representations, can be used to put the Bargmann–Wigner equations into the form of a single matrix equation. The same technique allows the Harish-Chandra β matrices to be written explicitly in terms of Dirac matrices. General arguments explain why the relativistic wave equations in general contain a certain number of arbitrary parameters, such as have been observed by several authors. The method is illustrated by several examples of relativistic wave equations. (auth)

42733 PROBLEMS OF GAUGE INVARIANCE IN COMPOSITE-PARTICLE THEORY. Cornwall, John M. (Univ. of Copenhagen). Phys. Rev., 182: 1610-16(June 25, 1969).

Ordinarily, a one-particle state in conventional field theory is said to be composite if $Z_1 = 0$, $Z_2 = 0$. (Z_1 and Z_2 are the usual vertex and wave-function renormalization constants.) The presence of neutral vector bosons coupled to a conserved current complicates the issues in two related aspects: (1) Z_1 and Z_2 become gauge-dependent, so that any equation like $Z_2 = 0$ is suspect, since the notion of compositeness should be gauge-invariant; (2) there is a theory (spinor-vector scattering) in which the spinor particle is automatically Reggeized, while one ordinarily expects only composite particles to lie on Regge trajectories. In this paper, it is shown that the notion of compositeness is indeed gauge-invariant. Further, it is shown that, in spinor-vector scattering, a special gauge may be selected in which the spinor shows some of the properties of a composite particle, and in which all manifestly non-Reggeized terms in the scattering amplitude vanish. Of course, the scattering amplitude is gauge-invariant, so there were no non-Regge terms to begin with. (auth)

42734 INFINITE-COMPONENT FIELD THEORIES, FUBINI SUM RULES, COMPLETENESS, AND CURRENT ALGEBRA. I. DISCRETE SPECTRA. Fronsdal, Christian (Univ. of California, Los Angeles). Phys. Rev., 182: 1564-70(June 25, 1969).

It is shown that the Born-approximation scattering amplitudes in a class of infinite-component field theories satisfy Fubini sum rules. The contributions to the sum rules are analyzed, and completeness relations are obtained. These are found to differ radically from the naive expectations. Singularities associated with the vertices give rise to cuts in the scattering amplitudes; the discontinuities contribute to the sum rule and hence to the completeness relations. Such contributions are incompatible with current algebra and with locality of the second-quantized form of the theory. Spacelike solutions, on the other hand, seem to be less relevant than has been feared. (auth)

42735 ABSENCE OF HIGHER-ORDER CORRECTIONS IN THE ANOMALOUS AXIAL-VECTOR DIVERGENCE EQUATION. Adler, Stephen L.; Bardeen, William A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 182: 1517-36(June 25, 1969).

Two simple field-theoretic models, (a) spinor electrodynamics and (b) the σ model with the Polkinghorne axial-vector current are considered, and it is shown in each case that the axial-vector current satisfies a simple anomalous divergence equation exactly to all orders of perturbation theory. The general argument is checked by an explicit calculation to second order in radiative corrections. The general argument is made tractable by introducing a cutoff, but to check the validity of this artifice, the second-order calculation is carried out entirely in terms of renormalized vertex and propagator functions, in which no cutoff appears. (auth)

42736 DO FASTER-THAN-LIGHT GROUP VELOCITIES IMPLY VIOLATION OF CAUSALITY? Fox, R.; Kuper, C. G.; Lipson, S. G. (Technion-Israel Inst. Tech., Haifa). Nature (London), 223: 597(Aug. 9, 1969).

It is stated that the properties of hypothetical systems in which group velocities exceed the speed of light appear at first sight to violate causality. In discussions of particles of imaginary mass (tachyons) Feinberg (Phys. Rev. 159: 1089(1967)) put forward an argument purporting to show that no causality violation is observable. It is stated, however, that this argument is incomplete, since the "events" considered were the emission or absorption of single tachyons. The present author considers the construction of a more general experiment in which a well defined pattern of correlated tachyons is used as a signal, and causality violation is observable. The subject is discussed with reference to the propagation of sound in ultradense matter and the theory of special relativity. (UK)

42737 EQUIVALENCE OF THE COULOMB GAUGE AND THE REFORMULATED LORENTZ GAUGE. Haller, Kurt (Univ. of Connecticut, Storrs); Landovitz, Leon F. Phys. Rev., 182: 1922-4(June 25, 1969).

A reformulated version of quantum electrodynamics in the Lorentz gauge is shown to be identical, in all of its physical consequences, to quantum electrodynamics in the Coulomb gauge. The reformulated Lorentz gauge has previously been shown to differ from the usual version of the Lorentz gauge in some important aspects. (auth)

Gravitation and General Relativity

42738 HLAVATY CONDITIONS IN GENERAL GEOMETRODYNAMICS. Nagaraj, Muppinaiya (Inidan Inst. of Science, Bangalore). Tensor, 18: 279-88(1967).

The discussion of Hlavaty conditions in general geometrodynamics covers the prequisites and the Weierstrass characteristics [112], [(11)11], and [(111)1]. (J.F.P.)

42739 SPHERICALLY SYMMETRIC SPACE-TIME KS-TYPE. Takeno, Hyoitiro; Kitamura, Shin-ichi (Hiroshima Univ. Fukui Univ., Japan). Tensor, 18: 301-8(1967).

A spherically symmetric space–time of the KS type is defined, the geometric properties of such a space–time are clarified, and some applications are made to relativistic theories. (J.F.P.)

42740 A GENERALISATION OF PLANE WAVE SOLUTIONS OF THE FIELD EQUATIONS IN GENERAL RELATIVITY. THE GENERAL TYPE NULL SOLUTIONS OF EINSTEIN–MAXWELL EQUATIONS. Johri, Vinod B. (Univ. of Gorakhpur, India). Tensor, 18: 330-4(1967).

In the geometrical formulation, plane gravitational waves are taken to be the nonflat solutions of the field equations in general relativity with the additional condition that in some suitable coordinate system all the components of the metric tensor are functions of a single variable Z(z,t), the phase function. An attempt was made at the generalization of plane wave solutions by assuming a space-time metric, wherein a certain component is not necessarily a function of Z. This approach has the advantage that the general solutions so obtained reduce, under restricted conditions, to plane wave solutions and the results corresponding to different types of plane gravitational waves can be deduced by suitable choice of the phase function Z. (auth)

42741 A PHYSICAL CONSTANT IMPLIED BY THE AUTHOR'S RESTRICTION TO EINSTEIN'S UNIFIED FIELD THEORY. Nix, E. D. Tensor, 18: 202-4(1967).

By use of a "preferred" coordinate system to Einstein's unified field theory (either the real-theory or the earlier Hermitian-theory), it is shown that a Doppler-like effect, in octaves per oersteds-squared, on a radiating object on which a constant magnetic or electric field is imposed would be theoretically observable from outside the field. The effect would be to shift the object toward the violet if the real theory applies, and toward the red if the Hermitian theory applies. Any successful experimental measurement of this effect seems very unlikely but such a successful measurement would seem to determine a choice between the two theories. (auth)

42742 SOME PROPERTIES OF EINSTEIN–MAXWELL FIELDS. II. (SPECIAL CASES). Nagaraj, Muppinaiya (Bangalore Univ., India). Tensor, 18: 119-29(1967).

Various special cases that arise in the study of Einstein–Maxwell fields are considered. Admissible Weierstrass characteristics for Einstein–Maxwell fields and special cases of the Einstein–Maxwell fields when the admissible WCh is [(11)11] are discussed. (J.F.P.)

42743 SOME PROPERTIES OF EINSTEIN–MAXWELL FIELDS. I. Nagaraj, Muppinaiya. Tensor, 18: 65-76 (1967).

The study of some properties of Einstein–Maxwell fields is the main objective. Starting with the gravitational potentials $h_{\lambda\mu}$ as the (given) components of the metric tensor for the four-dimensional Riemannian space-time V_4, the Einstein–Maxwell field equations in the presence of charge ϵ, mass μ, pressure p (in the sense of H. Poincaré: are solved for the unknowns. In fact, it will be shown that the parameters M and σ (which, with charge ϵ, characterize the electromagnetic field) are, respectively, algebraic and differential concomitants of R^{μ}_{λ}. So also will the charge ϵ be seen to be a differential concomitant. (auth)

42744 COMBINED BONDI AND FAST APPROXIMATION METHOD IN GENERAL RELATIVITY. I. THE AXI-SYMMETRIC CASE. Unt, V. Izv. Akad. Nauk Est. SSR, Fiz. Mat., 18: 169-85(1969).

The fast approximation expansion of the Einstein field equations is used and Bondi's method is applied to integrate the n-th order equations. Equations for the Fourier coefficients (of the transverse metric and integration functions) are given as well as the expressions for the metric. The outlines of the derivation will also be found. The integration of the equations for the Fourier coefficients are considered. The following results are obtained. The mass loss of a source is described in the metric by an angle-independent quantity. Expressions are given determining the recoil of a source and the deflection of rays in the field of the mass carried by waves. A new time coordinate is introduced in such a way that at least in the second approximation the conservation laws of Newman and Penrose no longer exist. As an example, the solutions of the equations for the Fourier coefficients for the quadrupole radiation in the second approximation are given. (auth)

42745 RADIATED ENERGY FAR FROM THE SOURCES BY A TWO-BODY SYSTEM. Signore, Monique (CNRS, Paris). Compt. Rend., Ser. A, 268: 1161-4(May 12, 1969). (In French).

A study is made of radiated energy far from the sources by a two-body system in the framework of the approximation method of general relativity applicable to rapid source motion. A comparison is made with an analogous study carried out in a Lorentz-invariant theory. (tr-auth)

42746 THE UNIQUENESS OF THE EINSTEIN FIELD EQUATIONS IN A FOUR-DIMENSIONAL SPACE. Lovelock, David (Univ. of Bristol, Eng.). Arch. Ration. Mech. Anal., 33: 54-70 (1969).

The Euler–Lagrange equations corresponding to a Lagrange density which is a function of g_{ij} and its first 2 derivatives are investigated. In general, these equations will be of fourth order in g_{ij}. Necessary and sufficient conditions for these Euler–Lagrange equations to be of second order are obtained and it is shown that in a four-dimensional space the Einstein field equations (with cosmological term) are the only permissible second-order Euler–Lagrange equations. This result is false in a space of higher dimension. Furthermore, the only permissible third-order equation in the four-dimensional case is exhibited. (auth)

42747 QUANTIZATION OF GRAVITATIONAL FIELD FLUCTUATIONS. Gowdy, Robert Henry. New Haven, Yale Univ., 1968. 335p.

Thesis.

Quantum general relativity is discussed within the framework of Feynman sum-over-histories quantization. The approach is illustrated by scalar field calculations. A treatment of differential geometry and general relativity in terms of differential forms is provided. The characteristic length, 8×10^{-33} cm, is obtained by assuming that particle quantization follows solely from the quantization of geometry. Gerald Rosen's result for field moments is obtained in the formalism and indicates a breakdown of Feynman's sum-over-histories rule for expectation values in general relativity. A perturbation expansion of field moments and the U matrix for general relativity is considered. Rosen's result is again verified in the zero order theory. The zero order U matrix is found to be reasonable for a free tensor field despite the surface terms in the integrated scalar curvature which was used for the action. It is also found that higher order terms cannot be ignored even for calculations involving only very small gravitational field fluctuations. Additional assumptions are needed to evaluate these terms. One such assumption, that only measurements which include the detection of a material particle should be represented by Hilbert space vectors which differ from the vacuum, is discussed. (Disser. Abstr.)

42748 VARIATION IN THE GRAVITATIONAL CONSTANT AND THE NEUTRINO LUMINOSITY OF THE SUN. Kuz'min, V. A. Kosm. Luchi, No. 10, 84-6(1969). (In Russian).

The influence of the time variation of the gravitational constant, $G \sim t^{-n}$, upon the evolution and the structure of the interior regions of the sun is discussed. The structure of the central region of the sun and the ^{8}B-, ^{13}N-, and ^{15}O-neutrino flux intensities prove to be quite sensitive to the value of G during the evolution. The experimental determination of the ^{8}B-, ^{13}N-, and ^{15}O-neutrino flux intensities may prove critical in solving the problem of the gravitational constant variations. (auth)

42749 CONSERVED QUANTITIES IN ASYMPTOTICALLY FLAT SPACE–TIME. Robinson, David Clyde. Syracuse, N. Y., Syracuse Univ., 1968. 95p.

Thesis.

The Newman–Penrose (N.P.) constants in flat and asymptotically flat space-times are considered. In Minkowski space-time the Kirchoff integrals for the zero mass free fields of arbitrary spin are calculated with the use of Green's theorem. These integrals express the fields in terms of initial data given on null surfaces and in the asymptotic limit become identical with the first set of N.P. constants when properly weighted. The higher order N.P. constants are associated with derivatives of these expressions. For fields derivable from a variational principle the Noether equations are constructed and used to identify the invariant transformations generated by the constants. The invariant changes in the fields are expressed in terms of the generalized Hertz potentials and have support confined to the null cone at infinity. The constants in asymptotically flat space-time are calculated by constructing the conformal compactifications of these spaces and using Green's theorem in these "unphysical" spaces. The appropriate Noether equations for the massless free fields of spin 0, ½, 1, the vacuum gravitational field and the Einstein–Maxwell fields are constructed, and conformally related to the above Green's theorem. The invariant changes in these fields are identified from these equations, and once again are zero at all points of physical space-time. (Disser. Abstr.)

42750 RESPONSE TO THE VARIATION OF AN EXTERNAL GRAVITATIONAL FIELD AND ITS IMPLICATIONS FOR EQUAL-TIME COMMUTATORS. Katzin, J. C.; Rolnick, William B. (Wayne State Univ., Detroit). Phys. Rev., 182: 1403-7(June 25, 1969).

Conjectures on the response of currents and the stress-energy tensor to variations of external gravitational fields have led to important statements about equal-time commutators (ETC's). The case is considered where only g_{00} is varied and it is proved that those conjectures are required by the general covariance of tensor fields. Although currents are known to be limits of nonlocal expressions, these limits may be taken before we vary g_{00}, and our theorem is applicable. However, physical properties of the vacuum preclude T^{ij} from behaving this way. To resolve this inconsistency, it is conjectured that $T^{\mu\nu}$ is the limit of a nonlocal expression. (A reformulation of Lagrangian field theory may be necessary.) Possible difficulties arising in the derivation of the ETC's are discussed using Schwinger's variational method, and it is shown that our theorem ensures that these difficulties are not present for ETC's of T^{00} with tensor fields. (auth)

42751 GRAVITON BREMSSTRAHLUNG AND INFRARED DIVERGENCE. Barker, Bruce M. (Louisiana State Univ., Baton Rouge); Gupta, Suraj N.; Kaskas, James. Phys. Rev., 182: 1391-6(June 25, 1969).

The graviton bremsstrahlung cross section for a spinless particle is obtained by including linear as well as nonlinear gravitational interactions, and the nonemission of nonphysical gravitons is established by direct calculations. The problem of infrared divergence in graviton bremsstrahlung is then resolved, and it is shown that for this purpose it is necessary to include the contributions of both the vertex and the self-energy diagrams in the radiationless scattering. (auth)

42752 GAUGE CONDITIONS IN GRAVITATIONAL INTERACTIONS. Barker, Bruce M. (Louisiana State Univ., Baton Rouge); Bhatia, Manjit S.; Gupta, Suraj N. Phys. Rev., 182: 1387-90(June 25, 1969).

The requirement of asymptotic gauge invariance in the scattering of a graviton by a spinless particle and in the annihilation of two spinless particles into two gravitons is analyzed, and it is shown that the necessary gauge conditions are satisfied by the scattering matrix elements for these processes. The scattering and annihilation cross sections for various graviton polarization states are also obtained. (auth)

42753 GENERALIZATION OF THE REISSNER–NORDSTROEM SOLUTION TO THE EINSTEIN FIELD EQUATIONS. Penney, R. (Ford Motor Co., Dearborn, Mich.). Phys. Rev., 182: 1383-4(June 25, 1969).

The field equations for coupled gravitational and zero-mass scalar fields in the presence of a point charge are solved in the spherically symmetric static case. The resulting solution is the generalization of the Reissner–Nordström solution in the presence of a zero-mass meson field. (auth)

42754 STATIONARY AXIALLY SYMMETRIC GENERALIZATIONS OF THE WEYL SOLUTIONS IN GENERAL RELATIVITY. Hoffman, Richard B. (Lehigh Univ., Bethlehem, Pa.). Phys. Rev., 182: 1361-8(June 25, 1969).

It is shown that a necessary condition that normal-hyperbolic solutions of the Einstein vacuum field equations for the metric tensor defined by the quadratic differential form $ds^2 = f du^2 - 2m du dv - l dv^2 - e^{2\gamma}(dx^2 + dz^2)$ (where f, l, m, and γ are functions of x and z, and $fl + m^2 = x^2$) be of type III or N is that $x^{-1}f$, $x^{-1}l$, and $x^{-1}m$ be functions of a single function μ; it is further shown that no such nonflat solutions exist. Solutions having this functional dependence are found to belong to one of three classes: the Weyl class and two classes which may be obtained from it. One of these classes is characterized by Sachs–Penrose type-I stationary solutions having one real and two distinct complex-conjugate eigenvalues. The other class is characterized by Sachs–Penrose type-II stationary solutions admitting a single shear-, twist-, and expansion-free doubly degenerate geodesic ray which is also a null, hypersurface-orthogonal Killing vector. Further invariant properties of these classes are discussed, as well as the special case where μ depends only upon x. (auth)

Scattering Theory

Refer also to abstract 42700.

42755 (ITF–69–34) ON THE CONNECTION OF THE KINEMATICAL AND ANOMALOUS CUTS WITH THE S-MATRIX ON THE MASS SHELL. Troitskii, V. E.; Shirokov, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 15p. (In Russian). (CONF-690417–12). Dep.

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The discontinuities through the kinematical and anomalous cuts of the current matrix elements $\langle 2|A(x)|0\rangle$ and $\langle 2|A(x)|2\rangle$ are connected with the S-matrix on the mass shell. (auth)

42756 IS THE JET STRUCTURE OF HIGH-ENERGY COLLISIONS OF KINEMATICAL ORIGIN? Kihlberg, Arne (Chalmers Univ. of Technology, Gothenburg, Sweden). Ark. Fys., 39: 77-88 (1969).

The wave function of a relativistic particle develops a peak in the spin space in the direction of its momentum. This suggests that the typical forward and backward peaks observed in high-energy scattering have a kinematical explanation. This is shown to be possible in a model which gives a Poincaré invariant and crossing symmetric scattering amplitude. (auth)

42757 LEFT-HAND CUTS IN REGGE TRAJECTORIES. Ball, J. S. (Univ. of Utah, Salt Lake City); Zachariasen, F. Contract AT(11-1)-68. Phys. Rev. Lett., 23: 346-8(Aug. 11, 1969).

It is suggested that all Regge trajectories $\alpha(t)$ have a branch point at $t = 0$ and are complex for negative t. A number of consequences and conjectures based on this possibility are discussed. (auth)

42758 AN UNAMBIGUOUS DEFINITION OF DUALITY FOR UNITARY AMPLITUDES. Childers, R. W. (Univ. of Tennessee, Knoxville). Phys. Rev. Lett., 23: 357-60(Aug. 11, 1969).

A new definition of strong duality is suggested, namely that crossed-channel trajectories are built out of direct-channel trajectories. This definition is unambiguous and reduces to the usual statement of strong duality of the resonance amplitudes are chosen appropriately. The role of unitarity appears to be of some importance, and it is found that the nonunitary Veneziano model does not exhibit strong duality defined in this way. (auth)

42759 DUALITY, UNITARITY, AND THE POMERANCHUK SINGULARITY. Freund, P. G. O.; Rivers, R. J. (Univ. of Chicago). Phys. Lett., 29B: 510-13(July 21, 1969).

A dual narrow resonance-Regge amplitude is unitarized. Regge trajectories are renormalized and acquire an imaginary part. Regge cuts appear. An SU(3)-singlet t-channel singularity builds up from the nonresonating s-channel background: the Pomeranchuk singularity. (auth)

42760 ABSORPTIVE PART OF AN AMPLITUDE AS A SCALAR PRODUCT. Malkov, E. I. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 29B: 491-2(July 21, 1969).

Some conditions imposed by the unitarity condition on two-particle amplitudes are considered for the case of spinless particles. (L.B.S.)

42761 KINEMATICAL CONSTRAINTS OF HELICITY AMPLITUDES. Levine, Donald M. (Univ. of Michigan, Ann Arbor). Nucl. Phys., B11: 641-58(1969).

The kinematical constraints of helicity amplitudes are studied using the general ideas of Jackson and Hite. The helicity amplitudes are expressed in terms of a Taylor series expansion from which all constraints at threshold and pseudothreshold can be trivially found. The simplicity of this approach is illustrated by deriving all of the constraints for $\pi\rho \to N\bar{N}$ and $\pi\rho \to \Delta\bar{N}$. (auth)

42762 NEW FINITE-ENERGY SUM RULES BASED ON THE MULTIPLE-SCATTERING MODEL FOR REGGE CUTS. Schrempp, F. (Institut fuer Experimentalphysik, Hamburg). Phys. Lett., 29B: 598-601(Aug. 4, 1969).

New finite-energy sum rules (FESR) are proposed for the single-scattering term in Glauber's multiple-scattering formula. In the presence of the whole set of Regge cuts, arising from multiple scattering, there occur only Regge poles on the high-energy side of these FESR. A new interpretation of duality is given, and other possible applications of the FESR are discussed. (auth)

42763 CONSEQUENCES OF ANALYTICITY AND FACTORIZATION: CLASSIFICATION OF REGGE TRAJECTORIES AND SATISFACTION OF CONSPIRACY RELATIONS. Capella, A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Tran Thanh Van, J.; Contogouris, A. P. Nucl. Phys., B12: 167-86(1969).

A general solution to the problem of determining the $t = 0$ behavior of the Regge residue functions, consistent with analyticity and factorization, is presented. This solution and certain analyticity requirements for individual helicity amplitudes are shown to lead to the group-theoretical classification of Regge trajectories. It is also shown that the presented solution satisfies the conspiracy relations for a large class of reactions containing all cases of present phenomenological interest. (auth)

42764 RELATIVISTIC QUASIPOTENTIAL EQUATION WITH LOCAL INTERACTION. Freeman, M. (Joint Inst. of Nuclear Research, Dubna, USSR); Mateev, M. D.; Mir-Kasimov, R. M. Nucl. Phys., B12: 195-215(1969).

A relativistic equation of quasipotential type with local interaction is studied. With the help of the method of varying constants, integral equations for the wave functions of the continuous spectrum are obtained and Jost functions are introduced. In the exactly soluble cases of square well potential and Coulomb potential the analytical properties of the scattering matrix are investigated. (auth)

42765 THE THREE-REGGEON VERTEX. Landshoff, P. V.; Zakrzewski, W. J. (Cambridge Univ., Eng.). Nucl. Phys., B12: 216-26(1969).

Properties of the three-Reggeon coupling function are examined. The expected form is given of its dependence on variables related to generalizations of the Toller angle. It is found that the Veneziano-type models for multiparticle amplitudes contain three-Reggeon vertices, with the correct structure; this provides a nontrivial check on these models. This structure is also checked in a model based on Gribov's hybrid perturbation theory approach. (auth)

42766 CLASS OF FUNCTIONS THAT SATISFY CROSSING SYMMETRY AND UNITARITY. Kupsch, J. (CERN, Geneva). Nucl. Phys., B12: 155-66(1969).

Atkinson's proof of the existence of functions that satisfy crossing symmetry and unitarity is extended to amplitudes given by a

Mandelstam representation with one subtraction. The inelastic unitarity bounds Im $f_1(s) \geq |f_1(s)|^2$ are obtained only for a finite interval of the energy, for higher values of s we only get $1 \geq$ Im $f_1(s) \geq 0$. The proof extends to positive and to oscillating double spectral functions. (auth)

42767 CAUSALITY IN S-MATRIX THEORY. II. Chandler, Colston (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta, 42: 759-65(Aug. 15, 1969).

Two scattering processes are discussed for which there exist points in the physical region of the mass shell at which the analytic S-matrix cannot be represented as the boundary value of a single analytic function. At such points the S-matrix must instead be represented as a sum of at least two such boundary value terms. (auth)

42768 N/D EQUATIONS WITH MARGINALLY SINGULAR KERNELS. Auberson, G. (Univ., Lausanne, Switzerland). Helv. Phys. Acta, 42: 729-39(Aug. 15, 1969).

The singular N/D equations which arise in the case of partial-wave dispersion relations with an asymptotically constant left-hand discontinuity $\phi(z)$ are investigated. It is proved that the resolvent (considered as an analytic function of the "coupling constant" $\lambda = \lim\phi(z)$) has a nonpolar singularity in the λ-plane. The location of the singular point is controlled $z \rightarrow \infty$ by the rate of inelasticity at infinite energy. This singularity gives rise to a multiplicity of solutions. (auth)

42769 N/D EQUATIONS IN THE POLE APPROXIMATION. Auberson, G. (Univ., Lausanne, Switzerland). Helv. Phys. Acta, 699-728(Aug. 15, 1969).

One-channel N/D equations are considered. A method is proposed allowing the construction of a convergent sequence of pole approximations for the left-hand cut. Then, the convergence of the corresponding sequence of approximate amplitudes is proved under specific conditions. This convergence holds especially in the physical region. Finally, the physical meaning of some abnormal cases is discussed. (auth)

42770 ANALYTIC EXTRAPOLATION OF SCATTERING AMPLITUDES. Pisut, J.; Presnajder, P. (Comenius Univ., Bratislava). Nucl. Phys., B12: 110-18(1969).

The method for extrapolation of amplitudes off the physical region lying interior to the domain of analyticity is proposed. It is essentially based on Cauchy theorem and subsequent approximations of the kernel $(z-a)^{-1}$ by polynomial approximants. Particular attention is paid to instabilities and to the determination of the best degree of approximation. The method is compared with direct polynomial expansions proposed recently by Cutkosky and Deo and by Ciulli. (auth)

42771 A GRAPHICAL METHOD FOR CONSTRUCTING N-PARTICLE VENEZIANO AMPLITUDES. Hori, Shoichi (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1601-3(June 1969).

A graphical method is proposed for the explicit construction of N-particle Veneziano amplitudes. (L.B.S.)

42772 THREE-BODY CALCULATIONS WITH LOCAL POTENTIALS. Brayshaw, D. D. (Columbia Univ., New York). Phys. Rev., 182: 1658-68(June 25, 1969).

A two-term separable approximation to the two-particle *t* matrix is developed which preserves exact behavior at each bound-state or resonance pole. While introducing no additional singularities, the approximation also produces the exact right-hand cut. This separable approximation is applied to the three-particle scattering problem with local potentials, and numerical results are obtained for the three-body binding energy in the case of the Yukawa and exponential potentials. A prescription is given for increasing the accuracy of this approach by systematically increasing the number of separable terms. This procedure is tested numerically, as is a method for estimating the error in such calculations. Binding-energy results are also presented for a modified pole approximation, and a simple explanation is given for the infinite-binding-energy phenomenon observed by Osborn for separable potentials. (auth)

42773 PHASE CONTOURS AND BOOTSTRAPS. I. Chiu, Charles B. (Cambridge Univ., Eng.); Eden, Richard J.; Green, Michael B.; Guerin, Francoise. Phys. Rev., 182: 1669-82(June 25, 1969).

Previous work on phase contours is extended to include reaction amplitudes that have Regge behavior at high energies. General results are obtained on relations between resonance poles and surfaces of zeros of the collision amplitudes. These results depend on the symmetry properties of the amplitudes and on the nature of the dominant Regge trajectories and the dominant resonances. They are also affected by the spin of the colliding particles. Zeros of collision amplitudes can be located asymptotically from Regge formulas, and along certain symmetry lines they can be located at finite values of the energy variables by means of a narrow-resonance approximation. The asymptotic zeros are related to these "symmetry" zeros by making a unitarity hypothesis. This leads to bootstrap conditions which are generalizations of the linear constraints contained in the Veneziano model. (auth)

42774 KINEMATIC STRUCTURE OF VERTEX FUNCTIONS. Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 182: 1469-74(June 25, 1969).

An invariant-amplitude expansion is obtained for vertex functions of fields belonging to arbitrary representations of the Lorentz group between states of arbitrary spins. The method is based on analysis of the singularities of the Lorentz-group parameters defining the vertex function. The restrictions due to parity and subsidiary conditions are also given. (auth)

42775 ANALYTICITY AND CAUSALITY. II. Screaton, G. R. (Oxford Univ.). Phys. Rev., 182: 1415-20(June 25, 1969).

A necessary and sufficient condition relating analyticity to causality for the one-dimensional analog of the S matrix is established. (auth)

42776 NONOSCILLATION AT HIGH ENERGY FROM A WELL-DEFINED BEHAVIOR OF THE PHASE FOR TWO-BODY SCATTERING AMPLITUDES. Gervais, J.-L. (Univ. de Paris, Orsay, France). Phys. Rev., 182: 1605-6(June 25, 1969).

It is proved that the criterion of nonoscillation introduced by Yndurain and the author is satisfied if the phases of the amplitude on the cuts have a limit at high energy. (auth)

42777 DUALITY AND SECONDARY TRAJECTORIES. Joshi, G. C.; Pagnamenta, Antonio (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., 182: 1574-8(June 25, 1969).

It is shown analytically that the slope of the dual or output trajectories is equal to the input slope for the partial-wave projections of the Regge amplitude. This result is independent of the special kinematics, and seems not to require a crossing-symmetric amplitude. An infinite set of secondary trajectories is found, and it is shown that their spacing depends on the slope and approaches $\Delta s = 2/\alpha'$ GeV^2 for large s. The detailed high-energy structure of some Argand diagrams is shown. (auth)

42778 REGGE CUTS, ABSORPTION MODEL, AND DIFFRACTIVE EFFECTS IN INELASTIC SCATTERING. Henyey, F.; Kane, G. L.; Pumplin, Jon; Ross, M. H. (Univ. of Michigan, Ann Arbor). Phys. Rev., 182: 1579-94(June 25, 1969).

A model is proposed for calculating Regge-cut contributions to scattering amplitudes in terms of a Regge-pole and elastic scattering. Physically, the cuts are caused by absorption effects. Our expression for the cuts contains only one parameter with limited range besides those associated with the Regge pole and elastic scattering. It is explicitly shown that combining absorption and Regge poles leads to no double counting. In this model all Regge poles are evasive at t = 0. This model, with π-exchange input, applied to the forward peaks in $\gamma p \rightarrow \pi^+ n$, $\pi N \rightarrow$ (transverse ρ)N, $np \rightarrow pn$, and $\pi p \rightarrow \rho\Delta$, is qualitatively the same as the absorption model, which is successful for these reactions. On the other hand, the conspiring Regge-pole model with factorization fails for $\pi p \rightarrow \rho\Delta$. The model with ρ-exchange input is also applied to $\pi^- p \rightarrow \pi^0 n$. The dip at $-t \approx 0.6$ BeV^2 in πN charge exchange is a diffraction minimum which, in the Regge language, is an interference between the Regge pole and the Regge cut. The Regge-pole contribution to the amplitude, taken by itself, has no dip. It is predicted that the dip drifts to smaller values of $-t$ as the energy is raised and the forward peak shrinks. The crossover effect in the $\pi^{\pm}p$ differential cross sections is also obtained. (auth)

42779 BOOTSTRAP OF PION–PION SCATTERING IN THE UNITARIZED STRIP APPROXIMATION. Collins, P. D. B. (Univ. of Durham, Eng.); Johnson, R. C. Phys. Rev., 182: 1755-61(June 25, 1969).

The result is given of a bootstrap of the ρ and Pomeranchuk trajectories in pion-pion scattering, using the unitarized strip approximation. In this scheme, an analytic, crossing-symmetric, unitary amplitude with Regge asymptotic behavior is constructed. This is achieved by starting with strips in which the double spectral function is parametrized by Regge poles, in the way devised by Chew and Jones, and adding the elastic double spectral functions in each channel calculated by the Mandelstam iteration method. Unitarity is imposed using the N/D method with inelasticity. Self-consistent trajectories are found which bear a fair resemblance to those found experimentally, at least for small $|t|$, and a ρ of width 155 MeV is obtained, which is very much better than earlier calculations. This and related improvements are due to the proper inclusion of Pomeranchon exchange. The requirement of self-consistency does not fix the trajectories uniquely, but the range of solutions is comparatively narrow, with $0.32 \leq \alpha_\rho(0) \leq 0.69$. There are still some unsatisfactory features in comparison with the phenomenological trajectories: It is found that $\alpha_\rho(\infty) > -1$, there is a too rapid increase of $\mathrm{Im}\alpha$ just above threshold, and the trajectories do not rise much above $\mathrm{Re}\alpha = 1$. Some conclusions are drawn about the prospects for this sort of S-matrix dynamics. (auth)

Particle Accelerators

Refer also to abstracts 40615, 41148, and 42603.

42780 (AEC-tr-7064) STABILITY OF NONUNIFORM ELECTRON BEAMS AND THE PROBLEM OF CURRENT LIMITS IN ACCELERATORS. Bogdankevich, L. S.; Zhelyazkov, I. I.; Rukhadze, A. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Preprint No. 167. 12p. Dep. CFSTI.

The stability of a relativistic electron beam in space accelerated by an inhomogeneous electric field is investigated under the conditions where the transverse dimensions of the beam is appreciably greater than the Debye radius, and a collective investigation is required for description of small oscillations. For currents exceeding the critical current, an instability can develop which is analogous to the slipping instability of nonrelativistic electron beams with a nonuniform velocity profile. The conditions of the instabilities are obtained, and the increments in their growth are calculated both in the absence of and the presence of a strong longitudinal magnetic field. The energy scattering of the electrons has a stabilizing effect on the investigated instability of the beam. In the appendix to the article it is shown that the slipping instability is characteristic of any inhomogeneous plasma flow. In particular, it can develop in an isotropic plasma with flow velocities exceeding the thermal velocity of the ions. (auth)

42781 (BNL-13674) CHARACTERISTICS OF THE AGS HIGH BRIGHTNESS ION SOURCE. Sluyters, Th. J. M. (Brookhaven National Lab., Upton, N. Y.). [nd]. 7p. (CONF-690625-1). Dep. CFSTI.

From International Conference on Ion Sources, Saclay, France.

The design and operation of the AGS duoplasmatron ion source are described. The source has a minimum lifetime of eight months. (W.H.K.)

42782 (BNL-13718) EXTENSION OF THE THEORY OF UNIFORM-PERIODIC IRIS-LOADED DEFLECTORS TO $\pi/2$-MODE BIPERIODIC STRUCTURES. Hahn, H. (Brookhaven National Lab., Upton, N. Y.). Apr. 24, 1969. 32p. Dep. CFSTI.

The extension of the rigorous theory of uniform-periodic iris-loaded deflectors to standing-wave $\pi/2$-mode biperiodic cavities is presented. Two versions of the solution for uniform-periodic deflectors are used. The first version is based on field matching similar to the early theories but it differs from these by the normalization procedure used. The second version is directly derived from the variational principle and matches the radial complex power flow along the interface rather than field components. It is shown that both versions represent a variational solution and lead to the best solution attainable with a given number of arbitrary coefficients in the field expansion. (B.G.D.)

42783 (BNL-13835) INVESTIGATION OF A SUPERCONDUCTING NIOBIUM CAVITY AT S-BAND. Hahn, H.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). [1969]. 10p. (CONF-690811-1). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

The unloaded quality factor was measured at low levels by the frequency-sweep technique, and power measurements were performed in the TE_{111} and TM_{011} modes at high levels. Low-level surface resistance of superconducting niobium at 4.2°K in the 2 to 4 GHz frequency range, variation of the low-level residual resistance with time, nonlinear resonant curves of TE_{111} and TM_{011} modes for slow fm signal, and the dependence of the surface resistance on the peak value of the rf magnetic field are presented graphically. (W.H.K.)

42784 (BNL-50155(Pt.1), pp 1-191) SUPERCONDUCTING RF CAVITIES AND LINACS. (Brookhaven National Lab., Upton, N. Y.).

BEAM SEPARATORS—design, operation, and performance of superconducting rf
CAVITY RESONATORS—development of high Q, high field, niobium, superconducting, for high-energy accelerators
—Q measurements on superconducting, at S band
—coupling losses in superconducting, (T)
—fabrication of high purity niobium superconducting, method for
—fabrication of high Q, niobium superconducting, method for
—radiofrequency losses in materials of superconducting characterization of residual
—Q measurements of superconducting, method for
—fabrication materials for superconducting, surface resistance measurements of indium and lead used as
—design of superconducting, for use in highly stable UHF oscillators
CYCLOTRONS—beam optics in 600-MeV microtron
HELIUM—fountain effect in superfluid, use for fabrication of fountain pressure pumps
LINEAR ACCELERATORS—development of high-intensity superconducting
—radiofrequency amplitude and phase stabilization in superconducting, feedback stabilization methods for
—particle motion in standing wave
—radiofrequency power feedback in superconducting, under beam loading conditions
REFRIGERATION—equipment for, development of 300 W superfluid helium
—equipment for, at temperatures below boiling point of helium
STANFORD LINEAR ACCELERATOR—superconducting materials for modified, analysis of Type I and II
—design parameters of superconducting version of
TECHNETIUM—use as material in superconducting accelerators and separators (B.G.D.)

42785 (BNL-50155(Pt.3)) PROCEEDINGS OF THE 1968 SUMMER STUDY ON SUPERCONDUCTING DEVICES AND ACCELERATORS. PART III. (Brookhaven National Lab., Upton, N. Y.). 1968. 423p. (CONF-680621-(Pt.3)). Dep. CFSTI.

A separate abstract was prepared for the two sections presented. (B.G.D.)

For abstracts of individual sections see: 42786 and 42787.

42786 (BNL-50155(Pt.3), pp 709-966) SUPERCONDUCTING MAGNETS. (Brookhaven National Lab., Upton, N. Y.).

ELECTROMAGNETIC LENSES—design and pole winding of superconducting quadrupole
—fabrication and testing of superconducting quadrupole
—design of superconducting quadrupole, with correcting dipoles
MAGNET COILS—stresses in cylindrical
—design study of intrinsically stable superconducting
—fabrication of superconducting test, cooled by helium forced circulation
MAGNETS—design of superconducting and cryogenic, stress problems associated with
—design of high-field hybrid, consisting of superconductors and nonsuperconductors
—stability in cooled superconducting, principles of
—design of 18-kG superconducting, for ANL 3.7-m bubble chamber
—design of superconducting for NAL 25-foot bubble chamber
—design of superconducting, for BNL 7-foot bubble chamber
—design of 70-kG superconducting, for Rutherford Laboratory 1.5-meter hydrogen bubble chamber
—design of superconducting, for European 3.7-meter bubble chamber
—performance of wide-strips fully-stabilized superconducting
—design study of superconducting multipolar
—design of superconducting dipole
—design of 40-kG bending, for Nimrod experimental area
—design of superconducting dc beam, at BNL
—properties of pulsed superconducting
—development of superconducting for thermonuclear research
—design of superconducting, for IMP magnetic mirror machine
—materials for superconducting standardization of tests for
—design of superconducting for NAL synchrotron experimental facilities
—microstabilization of Nb_3Sn, helium III
SUPERCONDUCTORS—microstabilization of Nb_3Sn, helium II (B.G.D.)

42787 (BNL-50155(Pt.3), pp 967-1132) ACCELERATORS AND STORAGE RINGS USING SUPERCONDUCTING OR CRYOGENIC MAGNETS. (Brookhaven National Lab., Upton, N. Y.).

ACCELERATORS—design of separated-function pulsed superconducting, 30 to 300 GeV
—economics of superconducting pulsed, in comparison with FFAG synchrotrons

ALUMINUM—properties and preparation of high-purity, for use in accelerator magnets
COPPER—radiation effects on, used in superconducting magnets, electron and neutron
ELECTRIC INSULATORS—radiation effects on electric and mechanical properties of, used in superconducting magnets, gamma and neutron
FFAG SYNCHROTRONS—design of superconducting
—magnetic fields of separated-sector spiral ridge, calculations for number and positioning of Nb_3Sn superconducting ribbons for producing
—design of superconducting, for 30 to 300 GeV
—fabrication procedures for applying superconductors to
HELIUM—radiation effects on liquid, used in superconducting magnets, gamma and electron
MAGNET COILS—radiation dose inside superconducting accelerator, calculations of expected
MAGNETS—ac losses in superconducting, electric multiplier for determining
—radiation effects on superconducting accelerator
—radiation effects on nonsuperconducting metals of superconducting
—radiation effects on electric and mechanical properties of insulating materials of superconducting, gamma and neutron
—radiation effects on liquid helium in superconducting, gamma and electron
—shielding of air-core cryogenic and superconducting, use of iron for
NIOBIUM ALLOYS AND SYSTEMS—niobium–tin radiation effects on intermetallic compound Nb_3Sn, used in superconducting magnets, deuteron, neutron, and proton
—niobium–zirconium, radiation effects on intermetallic compound Nb_3Zr used in superconducting magnets, deuteron and neutron
—niobium–titanium, radiation effects on, used in superconducting magnets, deuteron
POWER SUPPLIES—development of synchrotron, based on superconducting energy storage
STANFORD LINEAR ACCELERATORS—development of superconducting version of, with recirculating beam
STORAGE RINGS—design of superconducting proton, economic aspects of
SYNCHROTRONS—development of superconducting, economic and technological aspects of
—design of superconducting proton, economic aspects of
—development of superconducting 2000-GeV proton
—magnet design with cryogenic exciting coils
TIN ALLOYS AND SYSTEMS—niobium–tin radiation effects on intermetallic compound Nb_3Sn, used in superconducting magnets, deuteron neutron, and proton
TITANIUM ALLOYS AND SYSTEMS—niobium–titanium radiation effects on, used in superconducting magnets, deuteron
ZIRCONIUM ALLOYS AND SYSTEMS—niobium–zirconium, radiation effects on intermetallic compound Nb_3Zr used in superconducting magnets, deuteron and neutron (B.G.D.)

42788 (CEA-R-3766) TABLE OF CHARGED-PARTICLE ENERGIES VS MAGNETIC FIELD STRENGTH × ORBIT RADIUS ($B\rho$) FOR A = 1 TO 7 ($100 < (B\rho) < 1200$ kG. cm). Bianchi, Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1969. 86p. (In French). Dep.

A table of charged particle energies versus magnetic field strength × orbit radius ($B\rho$) is presented. Particles p, d, t, $^3He^{++}$, $^4He^+$, $^4He^{++}$, $^6Li^+$, $^6Li^{++}$, $^6Li^{+++}$, $^7Li^+$, $^7Li^{++}$, $^7Li^{+++}$. Values of $B\rho$: 100 to 1200 kG. cm by steps of 0.5 kG. cm. Values of energies are given in keV. (auth)

42789 (CERN–69-16) HIGH FREQUENCY EFFECTS ON THE TRANSVERSE RESISTIVE WALL INSTABILITY IN PARTICLE STORAGE RINGS. Zotter, B. (European Organization for Nuclear Research, Geneva (Switzerland)). June 9, 1969. 53p. Dep.

The transverse resistive wall instability in particle storage rings is calculated for high frequencies, for which the wavelength is no longer large compared to the transverse dimensions of the vacuum chamber. A circular beam in a concentric vacuum chamber is considered for the calculation of the field components caused by a vertical oscillation of the beam as a whole (dipole oscillation). It is shown that the average electromagnetic force which acts on the beam as a whole, decreases with increasing frequency. In consequence, the dispersion relation coefficients U and V decrease with increasing frequency. Further, the frequency spread due to energy and amplitude dependence of betatron number and revolution frequency increases with frequency above a certain mode number, which usually lies well in the long wavelength region. Instability thresholds and growth times will therefore increase in the high frequency region, and a beam that is stable against dipole oscillation in the long wavelength limit will also be stable at high frequencies. Numerical values are inserted for the parameters of the ISR, and the decrease of the dispersion relation coefficients is shown graphically. The solutions are not self-consistent–except in the limit of long wavelength–since the forces are spatially dependent and tend to excite oscillations of the beam cross section. However, the spatially dependent terms are always small compared to the average force term at low frequencies, and may therefore be neglected. The correspondence of the derived field components to published expressions valid in the long wavelength limit is shown and is used as a check on their correctness. (auth)

42790 (JINR-P3-4409) POLARIZED PROTON TARGET AS THE NEUTRON POLARIZER. Luschikov, V. I.; Taran, Yu. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 43p. (In Russian). Dep.

Theoretical grounds of the method of neutron polarization by transmission through a polarized proton target are presented. In this way 65% polarization of neutrons in the resonance energy region (up to several tens of keV) was reached with the help of a target of lanthanum-magnesium nitrate (LMN) monocrystal reducing the intensity of the neutron beam by 5 times; the target area being 15 cm^2. The method is effective as well for the thermal and cold neutron polarization, giving a considerable gain in the aperture ratio as compared to the other known methods. Different cross sections which determine the effect of a neutron polarizer with the LMN crystal on 0.001-50 eV neutrons are presented. (auth)

42791 (JINR-P6-4487) MASS-SEPARATOR IN THE APPARATUS JASNAPP. Muziol, G.; Raiko, V. I.; Tyrroff, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 31p. (In Russian). Dep.

A short description of the designed apparatus for spectroscopic investigation of short-lived isotopes in the proton beam of the JINR synchrocyclotron is presented. The apparatus consists of chemical equipment for separation of the elements, electromagnetic mass-separator and a device for extraction of enriched isotopes from the collector. An expected value of the isotopes from the collector. An expected value of the isotope activity on the collector is estimated and different factors, this value depends on, are considered. (auth)

42792 (NP-tr-1829) AN ION SOURCE FOR INTENSE BEAMS OF NEGATIVE HEAVY IONS. Hortig, G.; Mokler, P.; Mueller, M. Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Phys., 210: 312-13(1968). 3p. Dep. CFSTI (U. S. Sales Only).

A rotating disc target with a continuously activated surface film by vapor deposition is described for the production of negative heavy ions by inert-gas ion bombardment. Currents of various negative ions obtained from targets vapor-coated with cesium are listed. (W.H.K.)

42793 (OU-LNS-69-2) ANNUAL REPORT, JANUARY 1968–DECEMBER 1968. (Osaka Univ. (Japan). Lab. of Nuclear Studies). 51p. Dep.

ALUMINUM-27—alpha inelastic scattering at 22.2 MeV, α and γ singles and coincidence spectra for (E)
BISMUTH-209—deuteron reactions (d,α) at 11 MeV, α spectra from
CYCLOTRONS—research and development at Osaka University 110-cm
—design study of 230-cm isochronous, at Osaka University
LANTHANUM-139—proton reactions (p,n) at 10 to 50 MeV, cross section for
LEAD-208—deuteron reactions (d,α) at 11 MeV, α spectra from
LUTETIUM-171—energy levels from thulium-169 (α,2n) reaction
MOLYBDENUM-92—proton reactions (p,γ) at 6 to 12 MeV, isomeric cross sections for (E)
NEON-20—alpha elastic scattering at 22.9 MeV, phase shift analysis of (E)
PALLADIUM-106—energy levels from silver-106 decay (E)
SILVER-106—electron-capture decay of isomeric, γ and conversion electron spectra from (E) (J.W.R.)

42794 (RHEL/R-177) PULSED MAGNET COMMAND SYSTEMS. Elliott, R T. (Rutherford High Energy Lab., Chilton (England)). Feb. 1969. 36p. Dep. UK 6s. 0d.

The command, or trigger, systems of pulsed magnets in separated particle beams at the Rutherford High Energy Laboratory constitute a large fraction of the complete magnet assemblies. Equipment in current use on magnets performing three distinct functions is described and illustrated, and future development is discussed in relation to present ideas. (auth) (UK)

42795 (RHEL/R-179) AN EXERCISE IN COMPUTER ASSISTED CONTROL USING AN ION SOURCE. David, D.; Jones,

P. F. (Rutherford High Energy Lab., Chilton (England)). Feb. 1969. 11p. Dep. UK 2s. 6d.

An account is given of the computer programme development for assisted control of accelerator equipment. Lessons have been learned which will be valuable in designing a system for the computer-assisted operation of a new extracted proton beam at Nimrod. (auth) (UK)

42796 (SLAC-PUB-624) SLAC: STATUS, RECENT PROGRESS, AND FUTURE PLANS. Neal, R. B. (Stanford Linear Accelerator Center, Calif.). July 1969. 10p. (CONF-690811-3). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

Operations, electron and positron beam performance, chopped beam capabilities, beam breakup, compensation for beam loading, major replacement components, and recent improvements and additions are discussed. (W.H.K.)

42797 (SLAC-PUB-626) TWO-MILE SUPERCONDUCTING ACCELERATOR STUDY. Herrmannsfeldt, W. B.; Loew, G. A.; Neal, R. B. (Stanford Linear Accelerator Center, Calif.). July 1969. 8p. (CONF-690811-2). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

The status of a study to explore the feasibility of converting the present SLAC 20 GeV two-mile accelerator to a 100 GeV superconducting machine is summarized. High-energy physics objectives, basic accelerator parameters, materials and prototype studies, the radiofrequency system, dewar system, refrigeration system, and the research area and beam transport system are discussed. (W.H.K.)

42798 (UCRL-18890) BEVATRON OPERATION AND DEVELOPMENT. [Report No.] 60, October–December 1968. Crebbin, Kenneth C. (California Univ., Berkeley. Lawrence Radiation Lab.). May 16, 1969. Contract W-7405-eng-48. 8p. Dep. CFSTI.

The beam was on for 89.8% of the operating time this quarter and accelerated 2.4×10^{18} protons. The Bevatron operated 123 12-hour periods for high energy physics and integrated a total of 720 12-hour periods of experimental high energy physics. Three primary experiments were completed this quarter. Substantial improvements were made in reducing the fine structure of the long beam spills for counter experiments. (auth)

42799 (UCRL-19242) COLLECTIVE-FIELD ACCELERATION. Sessler, Andrew M. (California Univ., Berkeley. Lawrence Radiation Lab.). July 4, 1969. Contract W-7405-eng-48. 15p. (CONF-690811-4). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

Diverse methods proposed for the acceleration of particles by means of collective fields are reviewed. A survey is made of the various currently active experimental programs devoted to investigating collective acceleration, and the present status of the research is briefly noted. (41 references.) (auth)

42800 COLLECTIVE ION ACCELERATION. Sarantsev, V. P. CERN Cour., 9: 198-201(July 1969).

Research and development progress at Berkeley, Karlsruhe, and Munich is reviewed; and problems in the formation of the electron–ion bunch, extraction of the electron–ion ring, acceleration of the electron–ion bunch, and ring stability are briefly discussed. (W.H.K.)

42801 HIGH VOLTAGE IN VACUUM. Rohrbach, F. CERN Cour., 9: 208-10(July 1969).

Research and development progress on the insulation of high voltage in vacuum and on the physics of electric arcs is briefly described. Technical developments with dc voltages, state of the theory, and application of the theory to pulsed voltages are discussed. (W.H.K.)

42802 FRANCO-RUSSIAN JOINT EXPERIMENTS AT THE SERPUKHOV ACCELERATOR. Ermolov, P. (Institut de Physique des Hautes Energies, Serpukhov, USSR). Energ. Nucl. (Paris), 11: 161-6(May 1969). (In French).

The commissioning, in 1967, of the Serpukhov accelerator has opened up broad scientific prospects for physicists in an energy field that was hitherto inaccessible. The "Mirabelle" bubble chamber, which will be added to it, will make it possible to start the study of resonances, the interaction between hyperons and protons, regularities in high energy non-elastic processes and small desintegration of strange particles. (auth)

42803 COMPUTER CALCULATION OF AXISYMMETRICAL MAGNETIC FIELDS FOR AN ACCELERATOR. Kumagai, Michikazu (Tokyo Shibaura Electric Co., Ltd.). Jap. J. Appl. Phys., 8: 961(July 1969).

A computer program has been written to calculate the magnetic field distribution for a circular accelerator. The program computes axisymmetrical three-dimensional magnetostatic fields, which include the effect of coil current distribution. Permeability of the iron pole is assumed to be infinite. The method of a modified scalar potential has been applied in two-dimensional fields with current carrying regions. The modified scalar potential for axisymmetrical fields. (B.G.D.)

42804 NEW TYPE 6 MeV MEDICAL LINEAR ACCELERATOR, NELAC-1006 D. Otani, S.; Matsuoka, A. (Nippon Electric Co., Tokyo). NEC (Nippon Elec. Co.), Res. Div., No. 93, 42-54(Apr. 1969). (In Japanese).

Since NEC developed the first medical linear accelerator in Japan, it has manufactured and delivered some dozen units. Based on the technical capacity which has resulted from years of experience in electronics, NEC has made comprehensive improvements to the conventional equipment and completed a new type 6 MeV medical linear accelerator, NELAC-1006 D. The general features, performance, and principal specifications of the new equipment are outlined. The new electron system and its performance are especially discussed. (auth) (NSA of Japan)

42805 EFFECT OF AN ELECTRON BEAM ON THE ACCELERATION SYSTEM OF A SYNCHROTRON. Chumakov, A. S. Tr. Tomsk. Inst. Radioelektron. Elektron. Tekh., No. 5, 43-8 (1967). (In Russian).

The problem of exciting a resonator in a synchrotron by a beam in which the charge distribution can be determined by means of the mutual solution of the motion and field equations in the resonator is solved. For the sake of simplicity, the case of complete coordination of the high-frequency generator and the resonator was investigated. (tr-auth) (JPRS)

42806 EQUATIONS FOR CHARGED-PARTICLE MOTION IN A CONSTANT MAGNETIC FIELD AND VARIABLE ELECTRIC FIELD. Linkovskii, Zhozef. Rev. Roum. Phys., 14: 45-51(1969). (In Russian).

Approximation solution methods are given for particles moving with near-light velocities in constant magnetic fields and in alternating electromagnetic field. Linearization of equations and method sequence methods were used for non-relativistic cases, and a special method of motion quantization was used for relativistic cases. (R.V.J.)

42807 LINEAR ION ACCELERATORS. Hubbard, Edward L. (Univ. of California, Berkeley). Advan. Electron. Electron Phys., 25: 1-95(1968).

A survey of the design, development, and operation of linear ion accelerators is presented. Topics include accelerating structures, longitudinal motion, transverse motion, rf cavity design parameters, sources of rf power, field distribution in long linac cavities, injection, applications of linacs, and superconducting linacs. (179 references) (W.H.K.)

42808 ANALYSIS OF DENSE ELECTRON BEAMS. Amboss, K. (Hughes Research Labs., Malibu, Calif.). Advan. Electron. Electron Phys., 26: 1-170(1969).

The equations describing the electron flow including the Liouville equation for N particles, derivation of the one-particle distribution function, invariants of the nonthermal flow, derivation of the action function, and the classification of electron beams are presented. Calculation of the macroscopic properties of static dense beams using the one-particle distribution function including self-consistent flow in the infinite planar diode and axially symmetric finite solid beams from planar emitters is described. Self-consistent flows derived under the neglect of the initial thermal velocity distribution with solutions obtained directly from the Lorentz equation, flows derived by use of the action function W, and electrode design are described. Also, nonanalytic methods of obtaining self-consistent space charge flows are considered; the solution of Poisson's equation in finite difference form and the computation of the self-consistent trajectories and space charge distribution are presented. (209 references) (W.H.K.)

42809 DEVICE FOR GENERATING NEUTRONS. Miyoshi, Katsuhiko (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-12793. May 27, 1969. Filed May 14, 1965.

In neutron generators, in general, the output voltage of a high-voltage generator tends to fluctuate, due to the current used, resulting from the high internal resistance. Then, the current in the accelerating tube and also the voltage change, which is not desirable. To avoid this, a current of a specific load, in addition to the (deuteron-beam) current, flows, decreasing the change in the current used. By the method proposed, the size of voltage-dividing resistors can be small, the accelerating voltage is stabilized. The neutron generator, as usual, includes the following: the base plate; an upright narrow plate set on the base plate; an accelerating tube, supported by the upright plate, consisting of accelerating electrodes and voltage-dividing resistors; a high-voltage terminal at one end of the accelerating tube; a target at the other end; and a high-voltage generator. A bleeder resistor is connected to the output terminal of the high-voltage generator, separate from the voltage-dividing resistors. (NSA of Japan)

42810 DEVICE FOR GENERATING NEUTRONS. Inoue, Minoru (to Hitachi Ltd.). Japanese Patent 1969-8480. Apr. 3, 1969. Filed Aug. 6, 1965.

In the method proposed, ^{3}T(^{2}D,n) or ^{2}D(^{2}D,n) nuclear reactions are employed to produce fast neutrons. The advantages obtained are as follows: constant rate of neutron generation for long periods, easy and instant control of the generation, high accuracy in the generation control, leading to the industrial application of the method. The device consists of the following: a deuteron source; a deuteron accelerator; a target containing either deuterons or tritons; a neutron detector placed near the target; a device for comparing the detected neutron output with the standard; and a device for adjusting the deuteron-accelerating voltage according to the detected output and hence to the comparison of the output and standard. As the neutron output detected decreases, the accelerating voltage is increased automatically, and vice versa. As the neutron detector, a BF_3 counter with moderator cladding is desirable, which has a superior plateau characteristic. (NSA of Japan)

42811 HEAVY ICE AND DEUTERIUM DRIVE-IN TARGETS FOR dD NEUTRON PRODUCTION. Koralewski, Jozef; Rurarz, Edward; Tys, Jan (Instytut Badan Jadrowych, Swierk, Poland). Nukleonika, 14: 1-10(1969). (In Polish).

A source of neutrons from the dD reaction has been constructed having the following characteristics: it can be used as a target with heavy ice or as self-loading target (self-loading on gold), when working with heavy ice, the thickness of the ice layer is reproducible, the system of monitoring the neutron flux by counting the protons from the competing reaction D(dp)T using the solid state detector is convenient, it is easy to calibrate the energy scale of charged particles emitted from the target by placing a small alpha emitter (e.g., ^{239}Pu) as a calibrating source near the semiconductor detector, and the amount of constructional materials used is very limited. The neutron yield was determined by counting the protons emerging from the target at an angle of 135° to the deuteron beam. The mean yield of neutrons from our heavy ice target at 175 keV deuteron energy was 6×10^5 n/s/μA. A decrease of the neutron yield with time for a single ice layer irradiated with an ion beam current of 25 μA was shown to occur. A yield of 0.6×10^5 n/s/μA was obtained from a self-loading target irradiated at 100 μA. (auth)

42812 MEASUREMENT OF DISCHARGE CHARACTERISTICS OF DUOPLASMATRON. Drska, L.; Kral, J.; Hulek, Z. (Technical Univ., Prague). pp 99-104 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Preliminary results obtained by studying the characteristics of hydrogen duoplasmatrons are discussed. Pressure dependence of anode current with the magnet coil current, the intermediate electrode resistance, the anode voltage, and the discharge current were parameters. (M.O.W.)

42813 EXPERIMENTAL DEVICES FOR DUOPLASMATRON STUDIES. Drska, L.; Hulek, Z.; Kral, J. (Technical Univ., Prague). pp 93-8 of Fourth Czechoslovak Conference on Electronics and Vacuum Physics, Held in Prague on October 7th–12th, 1968. Paty, Libor (ed.). Prague, Fourth Czechoslovak Conference on Electronics and Vacuum Physics, 1968.

See CONF-681053.

Several experimental devices for duoplasmatron studies were constructed. An apparatus is described for preliminary study of the discharge characteristics of the duoplasmatron operating with slowly and continuously variable pressure in the discharge space. The vacuum system is described along with measurement apparatus and techniques. (M.O.W.)

42814 FEW TECHNICAL DEVELOPMENTS IN CONNECTION WITH THE SYNCHROCYCLOTRON OF LYON. Gusakow, Mark (Faculte des Sciences, Lyon). Ind. At., 13: No. 5-6, 39-46(1969). (In French).

A few developments achieved at the Institute of Nuclear Physics of Lyon in connection with the synchrocyclotron are described. These include the system of particle identification, of connection, and of visualization of a linear calculator for studying nuclear reactions; the perfecting of deuterium and liquid tritium targets; and improvement of the energy resolution of the beam by a magnetic system comprising two analyzers and a trio of intermediate quadrupoles. (auth)

42815 LARGE GAP MAGNET (May 2, 1969) (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1894).

28 drawings.

This magnet is used with particle physics detectors such as spark chambers in research at accelerator sites. The magnet is water cooled, has a 24 in. gap, and a design field strength of 13 kG. The total weight of the magnet is 190,000 lbs. The conductor Al core weighs 8000 lbs. (For details see TID-4100 Suppl. 54) (F.S.)

42816 SWEEPING SYSTEM FOR THE CYCLOTRON EXTERNAL BEAM. Papureanu, S.; Andruscenco, P.; Macovei, M.; Molea, M.; Moteca, P.; Pascovici, Gh.; Stancu, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 91-8(1969).

A sweeping system for the cyclotron extracted beam is presented and design criteria for the deflecting plates are derived. The adopted power supply scheme leads to a considerable decrease of the necessary rf power to achieve a given beam shift. (auth)

42817 VACUUM EVAPORATOR WITH AN ELECTRON GUN FOR THE PREPARATION OF THIN TARGET. Uemura, Yoshiaki (Kyoto Univ.); Kakigi, Shigeru; Fujiwara, Noboru; (and others). Bull. Inst. Chem. Res., Kyoto Univ., 47: 114-22(Mar. 1969).

An apparatus with an electron gun was designed and constructed in order to prepare thin films used as targets in low energy nuclear physics experiments. With this apparatus, self-supporting thin films of 0.1 ~ 1 mg/cm^2 thick and 10 ~ 30 mm in diameter have been prepared from substances including lithium to bismuth. Targets prepared and coatings and soaks used are tabulated. (auth)

42818 ION SOURCE FOR THE CYCLOTRON OF KYOTO UNIVERSITY. Uemura, Yoshiaki (Kyoto Univ.); Kokame, Jun; Yamashita, Sukeaki; Kakigi, Shigeru; Fujita, Hirokazu; Kakui, Shuzo; Maruyama, Tadahiro; Sano, Kenji; Fukuzawa, Fumio. Bull. Inst. Chem. Res., Kyoto Univ., 47: 97-113(Mar. 1969).

The mechanical design features and operating characteristics of an arc-discharge type ion source with a hot-cathode and a floating electrode are described in detail. The ion source is made of wolfram and molybdenum in parts, so that it stands arc power of 800 watts. H_2^+ ion current of 90 μA and He^{2+} ion current of 30 μA are extracted through the deflector of the cyclotron of Kyoto University. Estimation of the lifetime of a filament is made from the rate of evaporation and is in good agreement with the observed lifetime. The mechanism of ion production in this ion source is considered. The temperature-rise of the floating-electrode is found to be the most important factor for the operation of this ion source. (auth)

42819 BEAM TRANSPORT SYSTEM OF THE KYOTO UNIVERSITY CYCLOTRON. Yanabu, Takuji (Kyoto Univ.); Miyake, Kozo; Ikegami, Hidetsugu; (and others). Bull. Inst. Chem. Res., Kyoto Univ., 47: 123-42(Mar. 1969).

The beam transport system of the Kyoto University Cyclotron consists of three parts, namely, quadrupole lens magnets, a steering magnet and a beam analyzing magnet. The specifications and beam optical properties of these systems are described. (auth)

42820 DESIGN AND PERFORMANCE OF A BROAD RANGE MAGNETIC SPECTROGRAPH. Uemura, Yoshiaki (Kyoto Univ.); Yamashita, Sukeaki; Yanabu, Takuji; Yamada, Yasumasa; Ohama, Taro; Kakigi, Shigeru; Nguyen, Dai-ca. Bull. Inst. Chem. Res., Kyoto Univ., 47: 143-53(Mar. 1969).

A broad range magnetic spectrograph of Browne and Buechner type was constructed. The energy range covered by this spectrograph is from maximum to 40% of the maximum. Design, performance and an example of the momentum spectrum of reaction products obtained with this spectrograph are described. (auth)

42821 SCATTERING CHAMBER FOR THREE-BODY NUCLEAR REACTIONS. Yanabu, Takuji (Kyoto Univ.); Fujita, Hirokazu; Gotoh, Masayuki; Iwasa, Tatsuya. Bull. Inst. Chem. Res., Kyoto Univ., 47: 154-61(Mar. 1969).

To study the non-coplanar events in the three body nuclear reaction, a scattering chamber of three dimensional freedom was constructed. Three sets of radiation detectors can be mounted and can move to any position in the scattering chamber. Design of and some experimental results obtained with this chamber are described. (auth)

42822 NEUTRON SOURCE BASED ON A 350 keV ACCELERATOR OF CHARGED PARTICLES. Bobyr, V. V.; Hofman, V. I.; Kryshtab, H. S.; Posokhov, M. O.; Prymenko, H. I. Visn. Kiiv. Univ., Ser. Fiz. Khim., No. 7, 65-7(1967). (In Russian).

A neutron source based on a 350 keV accelerator has been developed at Kiev University. The accelerator was constructed around a multiplying circuit with 3Ts18P tubes having a compensating inductivity in the last multiplication stage. The voltage for feeding the ionic source is supplied according to the capacitance column and the power output is produced by a resonance circuit. The ion current toward the target is 0.5 mA, thus making it possible to get more than 10^{10} n/sec. (auth)

42823 CYCLOTRON HAVING CHARGED PARTICLE AND ELECTRON BEAMS. Russell, Francis Michael (to Science Research Council). U. S. Patent 3,459,988. Priority date, Jan. 14, 1966, Great Britain.

Energy is supplied to the cavities of a separated orbit cyclotron by passing a pulsed beam of electrons through the cavities in such a phase relationship with the pulsed beam of charged particles being accelerated that power is coupled from the electron beam to the cavities and thence to the charged particles. (Official Gazette)

42824 EFFECT OF AN ELECTROSTATIC FIELD ON PARTICLE ACCELERATION AT CYCLOTRON RESONANCE. Schram, D. C.; Beukema, G. P. (EURATOM-FOM, Jutphaas, Netherlands). Physica, 42: 277-90(Apr. 21, 1969).

The effect of an electrostatic field parallel to a static magnetic field on the cyclotron resonance acceleration of electrons is studied. Exact relativistic calculations show that for electrostatic field strengths below a certain limit, which depends on the field strength of the electromagnetic wave and the index of refraction, a steady average energy gain occurs. At this limit the energy of the particle increases steadily without any oscillation, while above the limit a stepwise energy gain occurs. Sufficiently far above, an analytical nonrelativistic approximation yields a simple expression for the energy gain of electrons with an initially isotropic transverse velocity distribution. (auth)

42825 BEAM SCANNER. Ormrod, John H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Rev. Sci. Instrum., 40: 1247-8(Sept. 1969).

An instrument has been developed which measures the radial power density profile of a beam extracted from a duoplasmatron ion source. It measures profile densities between 10 and 1000 W/cm^2 provided the beam particles' range in tungsten is less than the resolution demanded. The instrument consists of a thin tungsten wire mounted on a stirrup which is passed through the beam. The deposited energy is mainly radiated away; some, from a small central portion of the wire, is selected by a collimator and detected by a photomultiplier. The instrument is easily calibrated to within 5% by passing a current through the wire. (auth)

42826 MEASUREMENT OF THE POLARIZATION OF A PROTON BEAM ACCELERATED IN CHARGE-EXCHANGE ACCELERATOR. Andreev, G. B.; Slabospitskii, R. P.; Lopatko, I. D.; Borovlev, V. I.; Taranov, A. Ya.; Lutsik, V. A. (Physical-Technical Inst., Kharkov). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 108(Jan. 1969). (In Russian).

After having made several improvements in the design of the Academy's polarized ion injector, a polarized proton beam was obtained. The polarization vector of this beam may be oriented parallel or perpendicularly with respect to the wave vector of the beam. The polarization of the proton beam was determined during the measurement of left-right asymmetry while studying the elastic proton scattering on carbon. Proton energies between 2.4 and 3.0 MeV were used to measure the left-right asymmetry. The polarized proton beam from the overcharged accelerator was directed onto the carbon foil. The elastically scattered protons were recorded by two semiconductor detectors placed at +61 and -61° in the laboratory coordinate system. It was found that the polarization of the accelerated beam was 0.44 ± 0.05 while the proton beam intensity on the target was 4.10^8 sec^{-1}. (TTT)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 41054, 41114, 42483, 42485, 42809, 42810, 42822, 43195, and 43198.

42827 (BMwF-FBK-69-17) THE APPLICATION OF SIMPLE THERMALIZATION MODELS TO NEUTRON SPECTRA CALCULATIONS IN INFINITE HOMOGENEOUS MEDIA WITH ARBITRARY ABSORPTION. Essig, K. (Karlsruhe Univ. (West Germany). Institut fuer Struktur der Materie). May 1969. 58p. (In German). Dep.

Calculations of neutron distributions in infinite homogeneous media were carried out assuming a 1/v absorption law. The "secondary model" reduces this problem to the solution of a second-order linear differential equation in the energy variable E. This simple thermalization model involves two functions characterizing the specific moderator structures. Suitable combinations of these functions were approximated by polynomials in $E^{1/2}$. A generalization of a method developed by Kunze permits the solution of the differential equation. This solution, being subject to some boundary conditions, shows an analytic behavior. Neutron spectra calculated with 6 – 8 parameters reproduce experimental data with good accuracy. (auth)

42828 (BNL-50149, pp 19-23) NATIONAL NEUTRON CROSS SECTION CENTER. Pearlstein, S. (Brookhaven National Lab., Upton, N. Y.).

The activities of the National Neutron Cross Section Center are discussed. A new data storage and retrieval system, SCISRS II, was developed to replace SCISRS. Progress was made in an effort to find a way for automated publication of angular distribution data. A systematic procedure was developed for estimating thermal fission and capture cross sections and fission and capture resonance integrals for transuranium isotopes. An optical model study of neutron total cross sections and elastic angular distributions for ^{206}Pb, ^{207}Pb, and ^{208}Pb was completed. A study of the resolved resonance region of ^{59}Co was initiated. (J.W.R.)

42829 (EURFNR-665) BASIC REQUIREMENTS OF ADVANCED NEUTRON DATA STORAGE AND RETRIEVAL SYSTEMS (CSISRS). Schmidt, J. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Mar. 1969. 46p. (KFK-941; EUR-4163; EANDC(E)-114(U); CONF-690204-2). Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

From I.A.E.A. Panel on Neutron Data Compilation, Upton, N. Y.

Advanced data storage and retrieval systems under development like CSISRS could be useful, if not become indispensable for a large variety of users within the nuclear community ranging from evaluators and reactor physicists to basic nuclear physicists, if these systems provide certain basic requirements. Some ideas and proposals pertinent to this question are given from the view point of an evaluator's experience and needs. A first requirement concerns a clear definition of what quantities, to what extent, and in what form should be compiled and supplied by such a system. A second requirement, in view of the unreliability of the nuclear data basis, particularly for fast reactor design, becomes of most urgent importance at present and in the future and concerns the physical documentation of the compiled data, i.e., the clear and comprehensive indication of the experimental conditions for which the respective compiled data are valid. A possible structure and details for such a physical documentation scheme are outlined on typical examples. A concerted effort of the data producers, compilers, and users is needed for the development of this documentation and its implementation, particularly for heavy fertile and fissionable nuclei and for standard reactions in the CSISRS files and a proposal is made how this aim could be achieved in practice. Finally, some third-generation computer requirements of CSISRS systems are outlined. (auth)

42830 (GESP-226) NSP KERNEL-DIFFUSION LIBRARY, KDLIBE, NS0910 (USER'S MANUAL). Henderson, W. B.; Edwards, W. E. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). [nd]. 422p. Dep. CFSTI.

The essential features necessary to use the NSP Kernel-Diffusion codes are described. All codes are written in FORTRAN IV for the GE-635 computer and are contained on a single library tape prepared by the System Editor. In addition to the capability of running each of the nine codes as an independent job or activity, a kernel-diffusion sequence composed of as many as six of the codes can be run as a sequence of activities, with certain data prepared by one code passed to succeeding codes via tape or disc. Optional card output can be used as part of the card input at a later time to begin the kernel-diffusion sequence at any activity. Since all data cards and control cards necessary to run any code on the library are decimal cards, the codes can be run remotely using the GERTS system with a teletype as the remote terminal. (auth)

42831 (LA-4201) ALGORITHM FOR COMPUTATION, AND TABLE OF VALUES, OF THE INTEGRAL $H_n(p,q) = (2\pi)^{-1/2} \int_0^\infty dww^{n-2} \exp\{-\frac{1}{2}(w-p)^2 - q/w\}$. Clendenin, W. W. (Los Alamos Scientific Lab., N. Mex.). June 17, 1969. Contract W-7405-eng-36. 136p. Dep. CFSTI.

An algorithm based on the expanding mesh interval method is used for computation of the integral $H_n(p,q) = (2\pi)^{-1/2} \int_0^\infty dww^{n-2} \exp\{-\frac{1}{2}(w-p)^2 - q/w\}$. For n = 1, 2, 3, 4, numerical values have been obtained over the parameter range $-5 \le p \le 20$ and $0 < q \le Q$, where Q increases from 18 for $p = -5$ to 180 for $p = 20$. The parameter mesh is sufficiently fine to provide for interpolation for all intermediate values of p and q. In addition, the algorithm can be used as a subroutine to obtain needed values within a program, with an average computing time on the CDC-6600 of 0.03 second per integral. Values of $H_n(p,q)$ for higher n can be obtained from a recursion relation. (auth)

42832 (UCRL-71645) FEW-SPEED MODEL FOR THERMAL MODERATOR MOTION. Canfield, Eugene H. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 1969. 3p. (CONF-690609-13). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

Hot Breit-Wigner cross sections were calculated using one-, two-, and three-speed models for thermal moderator motion. It was found that as the number of discrete speeds were increased the results rapidly approached those for a Maxwell distribution. (J.W.R.)

42833 TIME BEHAVIOR OF THERMAL NEUTRONS IN MODERATING MEDIA. Borysiewicz, M.; Mika, J. (Inst. of Nuclear Research, Swierk, Poland). J. Math. Anal. Appl., 26: 461-78(June 1969).

Some properties of the realistic nonisotropic scattering kernels in various types of moderators are derived which have direct consequences in time-dependent thermalization problems. The analysis is based upon the Van Hove theory of thermal neutron scattering. (J.W.R.)

42834 TRANSPORT THEORY. SIAM-AMS PROCEEDINGS HELD IN NEW YORK CITY, APRIL 5-8, 1967. VOLUME I. Bellman, Richard; Birkhoff, Garrett; Abu-Shumays, Ebrahim (eds.). Providence, American Mathematical Society, 1969. 334p. $11.00. (CONF-670410-(Vol.1)).

This volume of the conference proceedings is divided into four main sections: (1) Analytical Neutron Transport; (2) Numerical Neutron Transport; (3) Stochastic Aspects; and (4) Kinetic Theory and Plasma Transport. Each part contains four expository accounts of recent developments. These accounts provide a comprehensive survey of the current state of transport theory, and it is hoped that they will serve as a stimulus for research in this area. (L.T.W.)

42835 NEUTRON SOURCE OF ^{252}Cf. Moshkin, G. N.; Tyufyakov, N. D.; Shtan, A. S.; Yaskevich, V. S.; Baikalov, N. D. At. Energ. (USSR), 26: 384-5(Apr. 1969). (In Russian).

Californium-252 emits 3.7 neutrons per fission event with one gram of this isotope giving about 3×10^{12} neutrons/sec. An experimental source was prepared by precipitating ^{252}Cf from solution onto a depression in gold foil, covering and sealing in a glass ampule. The diameter of the activity along with the gold foil did not exceed 1 mm. The neutron yield measured on a long counter was 6×10^6 neutrons/sec. The energy composition of the neutrons was measured on a stilbene scintillation spectrometer (diameter and height of crystal was 30 min). The gamma background was suppressed by an electronic discrimination scheme. In addition the energy composition of the neutrons was also determined on a spectrometer having a proportional counter containing helium-3 and krypton. Deviations in the neutron energy spectrum from 0.8 to 5.0 MeV were not observed within the limits of the experimental error. (TTT)

42836 SENSITIVITY OF A NEUTRON SCATTERING MODEL TO THE MODE PARAMETERS. Sefidvash, F. (Reactor Lab., Otaniemi, Finland). J. Nucl. Energy, 23: 306-8(May 1969).

Additional results are given on the model of Sefidvash and Grant for polyphenyls [J. Nucl. Energy, 23: 225(1969)]. The effects of various parameter variations are tabulated, and the sensitivity of the scattering cross section to these variations is shown. Good agreement was found with experimental results on diphenyl and benzene. The model was also tested against experimental results on the rethermalization process in terphenyl. (UK)

42837 DETERMINATION OF DIFFUSION PARAMETERS IN LEAD WITH THERMAL NEUTRON PULSES. **Fleck, C. M.; Nunwarz, Christine (Oesterreichische Hochschule, Vienna). J. Nucl. Energy, 23: 283-8(May 1969).**

Diffusion parameters for thermal neutrons were measured in lead. By chopping a thermal neutron beam, δ-source bursts were produced at a Ni-scattering target. The lifetime l_0, the diffusion length L, and the diffusion coefficient D_0 were determined by examining the time dependent neutron density at different spatial points. The values obtained were $l_0 = (800 \pm 71)$ μsec, $L = (13.1 \pm 0.3)$ cm, and $D_0 = (215940 \pm 4320)$ cm²/sec. These results are compared with theoretical values obtained from the known cross sections. (auth) (UK)

42838 TIME-DEPENDENT NEUTRON THERMALIZATION IN HETEROGENEOUS MEDIA. **Beekmann, Richard Walter. Seattle, Univ. of Washington, 1968. 145p.**
Thesis.

An improved theoretical basis is presented for the interpretation of time-dependent measurements utilizing a pulsed neutron source in heterogeneous assemblies. Particular attention is devoted to the theoretical description of the observables of an experiment. This is in contrast to conventional descriptions which analyze the dynamic experiment from indirect static considerations. A procedure is given for an approximate solution to the space-time, multispeed diffusion theory in a finite medium with a finite number of absorption discontinuities. The method used, based on the source-sink formalism of Meetz, is an expansion in a double series of space-energy coupled eigenfunctions. The objective is the calculation of the decay constant and spectrum of the thermalized neutron flux following an initial pulse of fast neutrons. Calculations include investigation into the effects of the interaction of contiguous absorbing elements on the asymptotic decay constant and spectrum in both infinite and finite media. The effects of chemical binding and the energy dependence of the transport mean free path on the decay constant and spectrum are discussed. The nature and extent of boundary transients excited by the absorption discontinuities are shown to play a particularly important role. It is seen that under certain conditions an asymptotic spatial mode does not exist. It is shown that the imposition of macroscopic curvature not only introduces leakage as a supplementary phenomenon, but also changes both the decay constant and the cell spectrum due to the net effect of the interacting contiguous elements. Finally, the analysis of time-dependent buckling experiments in heterogeneous moderators perturbed by strong absorbers is discussed. The results of fundamental-mode, space-energy coupled, decay constant calculations for slab geometries using realistic scattering kernels are qualitatively compared with experiment. The results are shown to be superior to conventional one-group, time-independent, treatments in the interpretation of buckling measurements. It is shown that a proper treatment of the energy dependence of the transport mean free path is crucial to the understanding of time-dependent measurements designed to infer buckling changes induced by absorbing materials. (Diss. Abstr.)

42839 AXIAL PROPAGATION NEUTRON WAVES IN HETEROGENEOUS MEDIA. **Quddus, Md. Abdul. College Station, Tex., Texas A and M Univ., 1968. 132p.**
Thesis.

A theoretical study of the axial propagation of plane-thermal-neutron waves in a semi infinite heterogeneous subcritical assembly containing cylindrical fuel rods in a square pattern is performed in the framework of the P-1 approximation to the Boltzmann equation. The method is based on a modified form of heterogeneous reactor theory due to Feinberg and Galanin. The analysis is first carried out in the one group P-1 approximation and then extended to age-diffusion theory. Axial propagation of neutron waves is studied, analytically and numerically, by analyzing the time dependent part of the moderator flux in the assembly. An oscillating plane source of thermal neutrons placed at one face of the assembly is assumed to inject a plane wave of thermal neutrons which propagate along a direction parallel to the fuel rods. The thermalization effect is considered by assuming a time delay prior to appearance of the fission neutrons in the thermal group. The analysis predicts that the phase interference between the modes of propagation in the axial direction may give rise to resonances in the frequency response of the asymptotic moderator flux. A standing-wave-pattern is also predicted in the amplitude distribution of the oscillating part of the moderator flux in the axial direction. The relationship between the resonances and the system parameters are investigated. An experimental method which can be useful for the determination of the system parameters is suggested for systems in which the frequency response (of the amplitude and the phase) and the standing-wave-pattern can be measured. A computer code, WAVE 1, was developed (in FORTRAN IV) using the results of the diffusion approximation for the purpose of numerical calculation of the frequency dependent moderator flux for a subcritical assembly containing four identical fuel rods. The code is applicable for the case where strong interactions exist between the fuel rods. It can also be used for preliminary calculation of the primary heterogeneity effects in a many-rods-assembly where the moderator flux at a point in the moderator is determined mostly by the nearest fuel rods. Numerical calculations for a heavy-water-moderated natural-uranium subcritical heterogeneous assembly are presented in the graphical form. Comparisons with experimental results published in the literature are also made. The amplitude and the phase of the oscillating part of the moderator flux are computed in the frequency range from 0 to 2000 Hz for various values of the system parameters. The standing-wave-pattern is calculated at a fixed frequency of source oscillation. The effect of anisotropy of diffusion on the frequency response is also studied by numerical method. (Diss. Abstr.)

42840 ON THE DEVELOPMENT IN SPHERICAL HARMONICS OF THE DISTRIBUTION FUNCTION OF NEUTRONS IN THE SLOWING-DOWN PROCESS IN THE CASE OF ANY GEOMETRY. **Lupu, Gheorghe (Division of Theoretical Physics, Cluj). Rev. Roum. Phys., 14: 53-60(1969).**

By developing in spherical harmonics the distribution function of neutrons in the case of any geometry, a system of n equations with n + 1 unknowns appears. The approximation of n + 1 order was neglected in the calculation. The conditions for annulment of the term which contains the approximations of n + 1 order $(N_{n+1}(\vec{r},v\vec{w}))$ were studied. A physical interpretation of this condition is given, as well as the results obtained by integrating the equation under this condition. (auth)

42841 A NEW THEORETICAL APPROACH TO THE DETERMINATION OF FAST NEUTRON SPECTRA. **Volmerange, B.; Cadilhac, M. (Aix-Marselles Univ., France). J. Nucl. Energy, 23: 371-3(July 1969).**

A semi-analytical method is presented in which the formulation is differential with respect to the lethargy variable, well defined functions are used to describe the scattering laws, and there is no theoretical limit for the accuracy of the results. (UK)

42842 D_2O ABSORPTION CROSS-SECTION. **Silk, M. G.; Wade, B. O. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 23: 369(July 1969).**

A corrected value of 1.236 ± 0.103 mb is given for the absorption cross section of the D_2O molecule at 2200 m/s, derived from pulsed-neutron measurements. (UK)

42843 NEUTRON TRANSPORT FOR ANISOTROPIC SCATTERING IN ADJACENT HALF-SPACES. I. THEORY. **McCormick, N. J. (Univ. of Washington, Seattle). Nucl. Sci. Eng., 37: 243-51(Aug. 1969).**

The method of singular eigenfunction expansions is applied to time-independent one-speed problems in which there are two half-space media which scatter neutrons anisotropically. Integrals are derived which reduce the calculation of the expansion coefficients to the solution of a non-singular integral equation plus associated coupled equations. In general, none of the expansion coefficients are found in closed form. (auth)

42844 SYNTHETIC METHOD AS APPLIED TO THE S_n EQUATIONS. **Gelbard, E. M.; Hageman, L. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 37: 288-98(Aug. 1969).**

The synthetic method has been incorporated into a technique (called the S_n synthetic method) for accelerating the iterative solution of two-dimensional discrete ordinate equations. For model problems, convergence of the method is established and bounds on the rate of convergence obtained. The analytical results coupled with numerical results for more general problems indicate that the S_n synthetic acceleration technique is extremely effective for problems containing large regions where the ratio of the scattering to total cross section is close to unity. (auth)

42845 THEORETICAL NEUTRON PRODUCTION FROM HYDROGEN ISOTOPE REACTIONS. **Halbleib, J. A. Sr.; Scott, M. R. (Sandia Lab., Albuquerque, N. Mex.). Nucl. Sci. Eng., 37: 271-7(Aug. 1969).**

Extensive calculations were carried out for neutron production from the ^{3}H(d,n)^{4}He, ^{3}H(p,n)^{3}He, and ^{2}H(d,n)^{3}He reactions using hydrated titanium targets. Both thin and totally stopping targets were considered for ion energies up to 5 MeV. By using the appropriate ion energy, production angle, and reaction, and allowing an energy spread of 10%, it is found that one can obtain neutron current densities of the same order of magnitude with energies from 0 to 22 MeV except for the gap between 8 and 12 MeV. Above 1-MeV variation of all pertinent neutron production characteristics with target loading ratio is found to be essentially the same regardless of reaction type, ion energy, or production angle. Total neutron yields are also calculated along with an example neutron-energy spectrum. (auth)

42846 NEUTRON TRANSPORT FOR ANISOTROPIC SCATTERING IN ADJACENT HALF-SPACES. II. NUMERICAL RESULTS. McCormick, N. J. (Univ. of Washington, Seattle); Doyas, R. J. Nucl. Sci. Eng., 37: 252-61(Aug. 1969).

The method of singular eigenfunction expansions is applied to the time-independent one-speed Milne problem in which there are two half-space media. It is assumed that scattering in each medium is at most linear in the cosine of the scattering angle; closed form expressions are then obtained for the expansion coefficients. Numerical results show the dependence upon the scattering parameters of the extrapolation distance and the discontinuities in the asymptotic densities and currents at the interface. These results give the proper boundary conditions to be applied when using diffusion theory in problems involving two or more plane layers which are thick as compared to the mean-free-paths of the media. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 42382, 42523, 42558, and 42635.

42847 (CEA-R-3726) CONTRIBUTION TO THE STUDY OF NEUTRON-NEUTRON INTERACTIONS USING THE THREE-NUCLEON EXPERIMENT D(n,nnp) AT 14.5 MeV: EVALUATION OF PARASITIC EVENTS. Ducharme, Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 30p. (In French). Dep.

Thesis. Submitted to Univ. of Grenoble, Faculte des Sciences, France.

This work is related to the interpretation of the results concerning the three-nucleon experiment, D(n,nnp), at 14.5 MeV, carried out by double time-of-flight spectrometry. The present work consists in the simulation of the main parasitic events using the Monte Carlo method for extracting them from the experimental distribution around the n-n pole. (auth)

42848 (ORNL-tr-2163) INTERACTION CROSS SECTIONS OF NUCLEONS WITH HELIUM. Barashenkov, V. S.; Eliseev, S. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-4333. 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 25771.

42849 EXCITATION OF THREE-NUCLEON SYSTEM. Mamasakhlisov, V. I.; Vashakidze, I. Sh. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 54: 317-20(May 1969). (In Russian).

The Hartree-Fock equation using the realistic separable potential of Tabakin for the ground state of three-nucleon systems was solved. Theoretically, the excited state $J^\pi = 5/2^-$, $\Gamma = 1/2$ lies above the ground state at 24.75 MeV, and the three-nucleon system has no excited states below 20 MeV. (auth)

42850 HARTREE-FOCK CALCULATION OF HELIUM HYPERNUCLEAR BINDING ENERGIES. Gibson, B. F.; Goldberg, A.; Weiss, M. S. (Univ. of California, Livermore). Phys. Rev., 181: 1486-93(May 20, 1969).

The binding energies of the s-shell hypernuclei ($_\Lambda$H^4, $_\Lambda$He^5, and $_{\Lambda\Lambda}$He^6) were calculated in the Hartree-Fock model, using Gaussian particle-particle potentials. Parameters of the Λ-N interaction were determined from the experimental binding energies. These numerical results agree qualitatively with those of other calculations and also with the experimental Λ-N scattering data, if short-range repulsions are included. Equality of the Λ-N and Λ-Λ potentials is consistent with these calculations. (auth)

42851 INELASTIC NEUTRON-DEUTERON SCATTERING. Cromer, A. H. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Phys., A133: 357-64(1969).

A theory of the charge exchange process d(n,p)2n is presented which is based on an earlier theory of slightly inelastic proton-deuteron scattering. Calculations of the 150-MeV measurements of Measday are found to be in good agreement with experiment for protons scattered through 20° or less. Additional calculations at 150 MeV are presented, and the experimental requirements necessary to determine the n-n scattering length to 1 fm are discussed. (auth)

42852 SLOW-NEUTRON CROSS SECTIONS OF He, Ne, Ar, AND Kr. Rorer, D. C.; Ecker, B. M.; Akyuez, R. Oe. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys., A133: 410-16(1969).

Total neutron cross sections of He, Ne, Ar, and Kr were obtained from transmission measurements through pressurized gas samples using monoenergetic neutrons in the range 0.075 to 6.19 eV. Analysis of the energy dependence of the total cross sections yielded values for the scattering and capture cross sections for Ar and Kr. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 42382, 42534, 42558, 42845, 42978, and 42983.

42853 (KAPL-P-3834) COUPLED-CHANNEL CALCULATION OF ^{12}C-NEUTRON SCATTERING. Reynolds, J. T. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 18p. Dep. CFSTI.

Coupled-channel calculations were performed for ^{12}C neutron cross sections at 0 to 5 MeV. The calculations resulted in very good fits to the ^{12}C data on total cross sections, differential elastic cross sections, and polarization. (J.W.R.)

42854 (ORNL-tr-2148) ENERGY DEPENDENCE OF INTERACTION CROSS SECTIONS OF NUCLEONS WITH ATOMIC NUCLEI AT ENERGIES HIGHER THAN 50 MeV. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-4183. 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 19250.

42855 YIELDS OF PHOTONUCLEAR REACTIONS LEADING TO THE PRODUCTION OF ^{7}Be WITH BREMSSTRAHLUNG UP TO 60 MeV. Oka, Yoshinaga; Kato, Toyoaki; Yamadera, Akira (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 42: 981-4(Apr. 1969).

Beryllium, boron, carbon, oxygen, and fluorine targets with natural isotopic compositions were irradiated by bremsstrahlung with four maximum energies, 30, 45, 55, and 60 MeV, and the yields of ^{7}Be from each of these targets were determined by means of chemical separation and gamma-ray spectrometric measurements. The yields were obtained relative to the yield of the ^{12}C(γ,n)^{11}C reaction at each bremsstrahlung energy. The possible reaction pathways leading to the production of ^{7}Be were discussed. The exponential decrease in the yield value against the difference in mass between the target and the product nuclei was observed. (auth)

42856 THE (π^+,pp) REACTION AND THE STRUCTURE OF LITHIUM NUCLEI. Kopaleishvili, T. I.; Machabeli, I. Z. (Tbilisi State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 69-71 (Jan. 1969). (In Russian).

The ^{6}Li(π^-,nn)^{4}He reaction may not be described within the framework of the shell model. This problem was further studied by examining the (π^+,pp) reaction involving ^{6}Li and ^{7}Li nuclei with moving π^+ mesons, within the kinetic energy range of T_π = 30 to 100 MeV; the residual nuclei were obtained in both the ground and excited states. The process was studied in the two-particle approximation of the absorption mechanism, on the basis of the author's previous work; the interaction between the reaction products was neglected. The ground state, states with one excitation oscillation quantum (uneven states for ^{4}He and even states for ^{5}He), and states with two excitation quanta of the residual nucleus were examined. The distribution of the emitted protons and the cross section relationships of the above states were determined for various incident π^+ meson energies. The correlations were plotted for ^{6}Li and ^{7}Li nuclei. The reaction cross section under formation of a residual nucleus with 2 excitation quanta was found to be negligibly small. The ratio of the cross sections was found to increase as the kinetic energy of the incident π^+ mesons increased; this is attributed to the fact that with increasing kinetic energy the time of interaction is decreased, resulting in a lower probability of energy transfer to the residual nucleon. (TTT)

42857 ENERGY DEPENDENCE AND SPECTROSCOPY IN THE $^{16}O(p,d)^{15}O$ AND $^{15}N(p,d)^{14}N$ REACTIONS. Snelgrove, James Lewis. East Lansing, Mich., Michigan State Univ., 1968. 181p. Thesis.

A systematic study of the extraction of spectroscopic factors for the (p,d) reaction on light nuclei and the difficulties encountered in obtaining reasonable DWBA fits to the shapes of the angular distributions was made. Deuteron spectra and angular distributions were obtained for the $^{16}O(p,d)^{15}O$ reaction over an angular range of 10 to 165° in the center-of-mass frame for 25.52-, 31.82-, 38.63-, and 45.34-MeV incident protons. Partial angular distributions were obtained for other proton energies between 21 and 36 MeV. The elastic scattering of protons from ^{16}O was measured over the same energy range and used to obtain proton optical model parameters. Deuteron optical model parameters for the $^{16}O(d,d)^{16}O$ reaction were obtained from the literature for use in the DWBA exit channel calculations. DWBA calculations were performed using the Oak Ridge code JULIE, and spectroscopic factors were extracted for the 0.0 MeV, $\frac{1}{2}^-$ and 6.18 MeV, $\frac{3}{2}^-$ levels of ^{15}O. Unadjusted optical model parameters were used with a 3 F cutoff to obtain some agreement between the shapes of the experimental and theoretical angular distributions. The absolute values of the extracted spectroscopic factors were found to depend strongly on the value of the neutron bound state well radius used in the DWBA calculations. The best absolute values of the spectroscopic factors were obtained when the neutron bound state well radius was set equal to the proton real well radius, whereas relative spectroscopic factors were found to depend much less strongly on this parameter. The energy dependence of the differential cross section was reproduced by the DWBA calculations for deuterons in the exit channel having a center-of-mass energy greater than 22 MeV. The feature of the cyclotron was used in a scheme to eliminate part of the Q-dependence from the relative spectroscopic factors. The lack of any improvement indicates that the problems with the DWBA calculations are probably not in the deuteron channel. At least 30% of the $1p_{3/2}$ strength appears to be missing from the 6.18-MeV, $\frac{3}{2}^-$ level, with approximately 12% of the missing strength appearing in the 9.60- and 10.46-MeV levels. Small 2s-1d admixtures and a possible $1g_{9/2}$ admixture were observed in the ground state of ^{16}O. Energy spectra and angular distributions were obtained over an angular range of 10 to 145° in the center-of-mass frame for the $^{15}N(p,p)^{15}N$ and $^{15}N(p,d)^{14}N$ reactions at 39.84 MeV. Using the method determined by the $^{16}O(p,d)^{15}O$ work, spectroscopic factors were extracted for the levels in ^{14}N populated by $\ell_n = 1$ pickup. These values were found to be in excellent agreement with intermediate coupling predictions. The 2^+, T = 1 levels of ^{14}N at 9.17 and 10.43 MeV were found to be strongly mixed. The 13.72 MeV level of ^{14}N was unambiguously assigned $J^{\pi} = 1^+$, T = 1 on the basis of comparison with theoretical predictions, and a width of 210 ± 30 keV has been determined for this level. Angular distributions for all the ^{14}N levels populated in the $^{15}N(p,d)^{14}N$ reaction are shown. (Diss. Abstr.)

42858 INVESTIGATION OF THE FAST PHOTONEUTRON SPECTRUM OF OXYGEN ABOVE THE GIANT RESONANCE REGION. Nagle, Paul Curtis. Troy, N. Y., Rensselaer Polytechnic Inst., 1968. 201p. Thesis.

Photoneutron spectra from the reaction $^{16}O(\gamma,n)^{15}O$ were measured at bremsstrahlung end point energies in 5-MeV steps between 39.3 and 65 MeV for a reaction angle of 67.5°. Also, photoneutron spectra at 55 MeV for reaction angles of 30° and 135° were obtained. Cross sections in the photon energy range of 35 to 65 MeV at 67.5° for the transitions to the ground state and 6.16 MeV excited state of ^{15}O are reported. Angular distributions for neutron groups of 5-MeV widths are presented along with the cross sections in the giant resonance region for reaction angles of 30°, 67.5°, and 135° at a photon energy of approximately 55 MeV. Comparisons are made to relevant experiments with special emphasis on possible structure in the tail region (the intermediate energy region above the giant resonance region) of the ^{16}O total (γ,n) cross section. The experimental results are discussed in light of the recent theoretical efforts, in particular the quasi-deuteron model. The experimental results indicate that there is no structure in the ground state contribution to the total $^{16}O(\gamma,n)$ cross section. However, a definite statement concerning possible structure in the 6.16 MeV excited state contribution cannot be made. Consequently, this experiment does not make a definite statement concerning the possible structure in the $^{16}O(\gamma,n)$ cross section in the tail region. Definite fine structure in the giant resonance region is obtained, however. A branching ratio of 3 : 1 was determined for the 6.16 MeV excited state and ground state contribution to the total (γ,n) cross section in the tail region. The angular distributions of neutron groups in the tail region show a definite forward peaking between 60° and 70°. The angular distribution for the three major giant resonance peaks of ^{16}O show different variations. The experimental techniques as well as the data analysis procedure are discussed with emphasis on problems and reliability of data. Future experiments and possible improvements are also proposed. (Diss. Abstr.)

42859 CALCULATION OF THE GROUND-STATE ENERGY OF THE ^{16}O NUCLEUS WITH A CENTRAL POTENTIAL WITH HARD CORE. Grypeos, M. E. (Univ. of Surrey, Guildford, Eng.). Nuovo Cim., Lett., 2: 117-21(Aug. 1, 1969).

The ground-state energy of ^{16}O was calculated using a hard-core central potential. A separation distance was introduced for determination of the matrix elements of the effective interaction. A value of −109.8 MeV was obtained. (J.W.R.)

42860 ELASTIC ELECTRON SCATTERING FROM ^4He. Stovall, T.; Vinciguerra, D. (Ecole Normale Superieure, Orsay, France). Nuovo Cim., Lett., 2: 17-21(July 1, 1969).

A model is presented for explaining the electron elastic scattering form factor for ^4He at values of the squared momentum transfer to 20 fm^{-2}. A fixed central potential and exponential wave functions give a satisfactory fit to the experimental data. (J.W.R.)

42861 ELASTIC SCATTERING OF 61.4-MeV PROTONS. Fulmer, C. B. (Oak Ridge National Lab., Tenn.); Ball, J. B.; Scott, A.; Whiten, M. L. Phys. Rev., 181: 1565-79(May 20, 1969).

Proton elastic scattering angular distributions were measured for ^{12}C, ^{27}Al, ^{40}Ca, ^{58}Ni, ^{68}Zn, ^{90}Zr, ^{116}Sn, and ^{208}Pb with a 61.4-MeV beam from the Oak Ridge isochronous cyclotron. An optical-model analysis of the data was performed. The results show a nuclear symmetry dependence of the optical-model potential; this dependence can be related to either the real well depth or the radius parameter of the real well. This study, combined with previously reported studies at lower bombarding energies, shows that for targets of $A \geq 27$ a potential with fixed-geometry parameters and an energy-dependent real well depth, $-(V - 0.4Z/A^{1/3}) \approx [49.9 - 0.215E + 26.0(N - Z)/A]$ MeV, will predict angular distribution in reasonable agreement with experiment for bombarding energies of 30 to 61 MeV. Data from light targets show a preference for large volume absorption and small surface absorption terms in the potential, while heavy-target data show a preference for small volume absorption and large surface absorption terms. The mean free path for a reaction of a 61-MeV proton in nuclear matter is estimated to be about 7½ F. (auth)

42862 PHASE-SHIFT ANALYSIS OF $^{16}O(\alpha,\alpha)^{16}O$ SCATTERING FROM 5 TO 10 MeV. John, Joseph; Aldridge, J. P.; Davis, R. H. (Florida State Univ., Tallahassee). Phys. Rev., 181: 1455-65(May 20, 1969).

Angular distributions for the elastic scattering of α particles by ^{16}O were measured at 10-keV intervals from a bombarding energy of 5.0 to 12.5 MeV. Real phase shifts were extracted by means of a partial-wave analysis of the data between 5 and 10 MeV. Twenty-seven resonances are found in the ^{20}Ne excitation energy range of 8.73 to 12.77 MeV. Seven of the corresponding levels in ^{20}Ne have not been previously reported. Spins and parities are assigned to 26, confirming a number of previously tentative assignments and correcting a few. Resonance widths are estimated for most of the levels. (auth)

42863 RECOIL BROADENING OF SECONDARY TRANSITIONS IN NEUTRON-CAPTURE GAMMA-RAY CASCADES. Wetzel, K. J. (Argonne National Lab., Ill.). Phys. Rev., 181: 1465-76(May 20, 1969).

Recoil Doppler broadening was observed in secondary γ-ray transitions (4 to 9 MeV) in cascades following thermal-neutron capture in ^{10}B and ^{14}N. An increase in linewidth (typically 0.5 to 1.5 keV) is measured by use of a Ge(Li) pair spectrometer. An ambiguity in the $\gamma_1-\gamma_2$ angular correlation $W(\theta)$ exists in most cases and introduces an uncertainty in the calculated linewidths, but measured widths generally fall within the range of the calculations. A comparison of results in ^{15}N from a gas sample and from a Melamine sample shows an attenuation of the effect for the 5271- and 5299-keV levels, and estimates of their lifetimes are consistent with known values. For ^{15}N levels showing no attenuation, the estimated lower limits on the lifetimes are also consistent with previous measurements; the lifetime for the 8313-keV level is an improvement over existing information. A more accurate value is also deduced for the lifetime of the 6741-keV level in ^{11}B from a comparison of the calculated and the observed broadening. It is also shown that in certain cases the Doppler broadening could provide information about the spin of the capturing state through the dependence of $W(\theta)$ on J_c. (auth)

42864 STUDY OF THE REACTION $^{12}C(d,p)^{13}C$ WITH THE WEAKLY-BOUND-PROJECTILE MODEL. Pearson, C. A.; Wilcott, J. C. (Univ. of Arizona, Tucson). Phys. Rev., 181: 1477-85(May 20, 1969).

Predictions of the weakly bound-projectile model are compared with measured differential cross sections, polarization, and vector-analyzing power for the reactions $^{12}C(d,p)^{13}C$ (g.s.) at deuteron energies between 7.0 and 26 MeV, and $^{12}C(d,p)^{13*}C$ (3.09 MeV) between 10 and 15 MeV. All the measurements are accounted for without any compound-nucleus resonance effects. It is suggested that previous failures to fit such data with the distorted-wave Born approximation stem from its inadequate description of the stripping mechanism. (auth)

42865 $^{12}C(d,n)^{13}N$ TOTAL CROSS SECTION FROM 1.2 TO 4.5 MeV. Jaszczak, R. J.; Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 181: 1428-30(May 20, 1969).

The total cross section for the $^{12}C(d,n)^{13}N$ reaction was measured for deuteron energies between 1.2 and 4.5 MeV using the Oak Ridge National Laboratory 5.5-MV Van de Graaff and a 4π graphite-sphere neutron detector. Thin natural-carbon targets (deposited onto platinum backings by electron bombardment of carbon) of thicknesses 80.0 ± 0.5 and 92.0 ± 0.5 $\mu g/cm^2$ were used to derive the cross-section values. Ten peaks were observed in the total cross section in the above energy region. The thin-target yield was numerically integrated and a comparison was made with the experimentally determined thick-target yield. The usefulness of the $^{12}C(d,n)^{13}N$ reaction for the production of an accurately known flux of monoenergetic neutrons and its importance in the absolute calibration of neutron detectors are discussed. (auth)

42866 ISOBARIC-SPIN IMPURITIES OF ^{18}F STATES FROM $^{14}N(\alpha,n)^{17}F(0.500)/^{14}N(\alpha,p)^{17}O(0.871)$ CROSS-SECTION RATIOS. Schier, W. A.; Reber, J. D. (Univ. of Virginia, Charlottesville, Va.). Phys. Rev., 181: 1371-9(May 20, 1969).

A pair of mirror reactions initiated with α particles was chosen to estimate the isobaric-spin impurity of the intermediate compound-nuclear states in ^{18}F. Total-cross-section ratios of the $^{14}N(\alpha,n)^{17}F(0.500)$ and $^{14}N(\alpha,p)^{17}O(0.871)$ mirror reactions were measured in 100-keV steps from $E_\alpha = 7$ to 12 MeV by recording the isotropic deexcitation γ rays from the $^{17}F(0.500)$, $^{17}O(0.871)$, and $^{17}O(3.058)$ states. Considerable structure indicative of compound-nucleus formation was observed in the ratios plotted against α energy, with major maxima at $E_\alpha = 8.12$, 9.5, 10.07, and 11.52 MeV. Symmetric angular distributions at three of these maxima resulted in tentative spin assignments of (2^-) at a ^{18}F excitation of 10.764 ± 0.030 MeV, $(2^-, 3^-, 3^+)$ at 12.234 ± 0.030 MeV, and $(2^-, 3^+)$ at 13.361 ± 0.030 MeV. These states are unambiguously $T = 0$, in contrast with the forbidden-reaction isobaric-spin assignments, having estimated $T = 1$ impurities of 12%, 3–12%, and 2–3%, respectively. A comparison is made with earlier isobaric-spin-impurity measurements that utilized forbidden reactions, and the agreement is good after those forbidden-reaction estimates incorporating a statistical theory of the compound nucleus are reduced by a factor of $\frac{3}{2}$. This correction arises from the forbidden reactions proceeding through both impure $T = 0$ and impure $T = 1$ states, which are of comparable density in ^{18}F. (auth)

42867 PROTON POLARIZATION FOR $^{12}C(d,p)^{13}C$ REACTION NEAR $E_d = 3.0$ MeV. Sosnowski, Marek (Stanford Univ., Calif.). Nucl. Phys., A133: 266-72(1969).

The proton polarization was measured as a function of angle for the $^{12}C(d,p)^{13}C$ g.s. reaction from 30 to 120° (lab) in 15° intervals for deuteron energies 3.07 and 3.25 MeV and at 30° for 2.90 MeV. Polarizations as large as 60% were found. Angular distributions of the polarization at the two energies are significantly different indicating the interference of stripping and compound nucleus contributions. A carbon polarimeter with solid-state detectors is described in some detail. (auth)

42868 POLARIZATION IN $^{11}B(p,p)$ AND $^{11}B(p,p')$ AT 30.3 MeV. Karban, O.; Lowe, J.; Greaves, P. D.; Hnizdo, V. (Univ. of Birmingham, Eng.). Nucl. Phys., A133: 255-65(1969).

Polarizations and cross sections at 30.3 MeV are presented for $^{11}B(p,p)$ and $^{11}B(p,p')$ exciting the 2.14- and 4.46-MeV states. For the 2.14-MeV state the results are compared with coupled-channels calculations using shell-model nuclear wave functions. Poor agreement is found for a wide range of nucleon-nucleon forces. For the 4.46-MeV state, a model involving coupling of a $p_{3/2}$ hole to states of ^{12}C is investigated. (auth)

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Refer also to abstracts 40717, 40721, 41003, 42382, 42558, 42793, 42852, 42854, 42861, 42862, 42909, and 42965.

42869 (BMwF-FBK-69-7) NUCLEAR SPECTROSCOPY WITH THE $(^3He,\alpha)$ REACTION. David, P. (Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik). Mar. 1969. 164p. (In German). Dep.

The reactions $^{50,52,53,54}Cr(^3He,\alpha)$ were studied at an incident ^3He energy of 18 MeV. Spectroscopic factors for T< and T> states are extracted. They give information about the neutron configurations. Centres of gravity for the $f_{7/2}$, $d_{3/2}$ and $s_{1/2}$ orbits are determined. Coulomb energy displacements are obtained from the observation of $f_{7/2}$, $d_{3/2}$ and $s_{1/2}$ analog states at excitation energies between 5 and 13 MeV. The DWBA methods are re-examined for the $(^3He,\alpha)$-reaction. It is found that the use of the $(^3He,\alpha)$-reaction as a spectroscopic tool is limited by the angular momentum mismatch. The exact matrix-element of the distorted wave theory indicates that the α-potential should be roughly equal to the sum of the ^3He- and (bound)-neutron potentials. The effects of nonlocality and finite range are discussed. The influence of spin-orbit coupling on the angular distributions and the absolute cross-sections are investigated. The absolute normalization factor of the DWBA-cross section derived from the analysis of the data agrees with theoretical predictions. The bound state wave functions for configurational and analog states are discussed. (auth)

42870 (CEA-R-3458) CONTRIBUTION TO THE ELASTIC AND INELASTIC SCATTERING STUDY POLARIZED PROTONS. de Swiniarski, Rene (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 119p. (In French). Dep.

Thesis. Submitted to Paris Univ., France.

The elastic and inelastic scattering of the 18.6-MeV polarized proton beam was studied for the following nuclei: ^{48}Ti, ^{50}Ti, ^{52}Cr, ^{54}Fe, ^{56}Fe, ^{58}Ni, ^{62}Ni, ^{64}Ni, ^{63}Cu: the targets ^{52}Cr, ^{60}Ni and ^{62}Ni were also investigated at 16.5 MeV. The measured asymmetries for the strong $l = 2$ transitions tend to fall into two categories, distinguished by the magnitude of the asymmetries at 30° and 90°. For the transitions studied, only those to the first 2^+ state of the 28-neutron nuclei present large asymmetries at these angles. Strong $l = 3$ and $l = 4$ transitions show also interesting variations. When the entire optical potential is deformed, coupled-channels or DWBA calculations predict the "small" $l = 2$ asymmetry reasonably well, but only a normal increase of the strength of the spin-orbit distortion or the introduction of an imaginary and negative spin-orbit potential can reproduce the amplitude of the large asymmetries. Calculations with a microscopic model indicate that the asymmetry is sensitive to the form factor and no important differences were found between $S = 0$ and $S = 1$ predictions. (auth)

42871 (UCRL-18902) IN-BEAM PROTON GAMMA RAY COINCIDENCE STUDIES USING A LARGE COAXIAL Ge(Li) DETECTOR. Moss, Joel M. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 186p. Dep. CFSTI.

Thesis.

Two different applications were made of particle-gamma ray coincidence techniques: first, in the $^{54}Fe(p,p')^{54}Fe$ reaction at 10 MeV and then, in the reactions $^{54,56}Fe(p,p')^{54,56}Fe$ at 19.6 MeV. In both experiments a large coaxial Ge(Li) counter was used to detect the gamma rays. In the $^{54}Fe(p,p')^{54}Fe$ reaction at 10 MeV, the angular correlation of gamma rays coincident with protons detected near 180° was measured. On the basis of this information, unambiguous spin assignments were made to the 3.345(3), 4.074(3), 4.579(2), 4.781(3), and 4.949(4) MeV states. Model-dependent assignments and spin limitations were made for several other states. The angular correlation analysis also yielded multipole mixing ratios for several transitions and branching ratios for the decay of all states of ^{54}Fe below 5 MeV. From an analysis of the observed Doppler shifts of the coincident gamma rays, mean lifetimes were derived for the 1.409, 2.959, 3.164, 3.836, 4.048, 4.074, 4.265, 4.287, 4.781, and 4.949 MeV states. Coincident gamma rays perpendicular to the reaction plane, as a function of proton scattering angle, were observed in the reactions $^{54,56}Fe(p,p')^{54,56}Fe$ at 19.6 MeV. Analysis of these data yielded angular distributions of the spin-flip probability in the inelastic excitation of the first 2^+ states in both nuclei. The spin-flip probabilities were compared to the predictions of both the collective and microscopic models of inelastic proton scattering. (auth)

42872 DOPPLER EFFECT CONTRIBUTION TO THE MEAN LIFETIMES OF NUCLEAR EXCITED STATES. Aleonard, Marie-Madeleine; Castera, Danielle; Hubert, Philippe; Leccia, Francis; Mennrath, Pierre; Thibaud, Jean-Pierre (Laboratoire de Physique Nucleaire, Gironde, France). Compt. Rend., Ser. B, 268: 1272-5(May 12, 1969). (In French).

The mean lifetimes of the states 1.778-, 4.617-, and 6.272-MeV of ^{28}Si were measured. The values are, respectively, 665 ± 100, 40 ± 15, and 1100^{-200}_{+250} fs. (tr-auth)

42873 ISOSPIN MIXING OF THE ISOBAR-ANALOG RESONANCES OBSERVED FOR THE $^{59\ 61\ 63\ 65}$Cu NUCLEI. Guzhovskii, B. Ya.; Borkin, I. M.; Zvenigorodskii, A. G.; Rudnev, V. S.; Solodovnikov, A. P.; Trusillo, S. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 129-44(Jan. 1969). (In Russian).

Study of the isobar-analog resonances in the elastic scattering channel yields information similar to that obtained by the analysis of (d,p) reactions of the same target nucleus; it is also possible to determine with high precision the Coulomb energy for both the ground and excited states. Therefore, the isobar-analog resonances, observed in various decay channels (p,p_0), (p,p_1') and (p,n) were studied during the bombardment of ^{58,60,62,64}Ni nuclei by 3- to 8-MeV protons, using a previously described method. The reactions involved were: $^{64}\mathrm{Ni} + p = {}^{65*}\mathrm{Cu}$; $^{62}\mathrm{Ni} + p = {}^{63*}\mathrm{Cu}$; $^{60}\mathrm{Ni} + p = {}^{61*}\mathrm{Cu}$; $^{58}\mathrm{Ni} + p = {}^{59*}\mathrm{Cu}$. It was found that the relatively simple resonance structure of ^{65}Cu becomes more and more complex in the lighter ^{63}Cu, ^{61}Cu, and ^{59}Cu nuclei. The excitation energy, corresponding to the analogous ground states in these nuclei, increases substantially with increasing T_z, resulting in an increase of the density of the ground state. Thus, the change of the resonance structure is related to changes in the density of the ground states. The study of the isobar-analog resonances within a wide excitation energy range revealed systematic differences in the Coulomb energy for states belonging to the pf and sd shells in each of these nuclei; these differences amounted to 35 keV for ^{65}Cu and 80 keV for the other nuclei. (auth)

42874 THE ^{26}Mg(d,α)^{24}Na REACTION AND THE ^{24}Na–^{24}Mg–^{24}Al ISOBARIC MULTIPLET. Sadkovskii, V. S.; Teterin, E. D.; Denisov, A. E.; Kolalis, R. P.; Nemilov, Yu. A.; Pomytkin, V. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 123-8(Jan. 1969). (In Russian).

The energy spectrum and the angular distribution of α particles resulting from the ^{26}Mg(d,α)^{24}Na reaction were measured, using the deuteron beam of the cyclotron; the previously described counting chamber was modified to cover the emission angle range of 15 to 165° (laboratory system). The targets consisted of MgO, enriched to 87.3% in ^{26}Mg. As a result of the study, new data were obtained for the isobaric multiplet of nuclei with A = 24; they were compared with values reported earlier in the literature. Among the known levels of ^{24}Mg, two possible analogs of the 1.50-MeV level of ^{24}Na may be separated out: the levels with excitation energies of 10.92 and 11.08 MeV. The 11.08-MeV level observed in the ^{12}C(^{16}O,α)^{24}Mg reaction may be attributed to the disturbance of the isotopic spin selection law; however, at present it cannot be definitely established which state of ^{24}Mg is the analog of the 1.50-MeV level in ^{24}Na. (TTT)

42875 THE DECAY OF ^{76}Br. Dzhelepov, B. S.; Dmitriev, A. G.; Zhukovskii, N. N. (Radium Inst., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 14-26(Jan. 1969). (In Russian).

In order to obtain more precise data on the level energies of ^{76}Se and to determine the populations of levels resulting from the decay of ^{76}Br, the γ spectrum of ^{76}Br was investigated, using a Ge(Li) detector. Bromine fractions separated from Br, Y, and Sr targets irradiated with 660-MeV protons served as sources. The measurements were carried out during a period ranging from 0.5 hr to 8 days after irradiation; the system was calibrated up to 2500 keV with respect to the γ rays of RaC′, ^{77,80,82}Br, and peaks of the annihilation quanta of ^{76}Br. Ninety new γ lines were observed. On the basis of the currently available data, a decay scheme was proposed for ^{76}Br. The errors in the γ-ray energy measurement did not allow the allocation of the position of several γ transitions; there are not any data on conversion electrons in the spectrum and therefore the multipolar character of the transitions which accompany the γ decay is not known. For this reason no conclusions could be drawn concerning the quantum characteristics of the levels of ^{76}Se. (TTT)

42876 THE ELASTIC AND INELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS BY ^{23}Na AND ^{39}K NUCLEI. Savitskii, G. A.; Afanas'ev, N. G.; Gul'karov, I. S.; Kovalev, V. D.; Khvastunov, V. M.; Shevchenko, N. G.; Andreeva, I. V. (Physical-Technical Inst., Kharkov). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 60-8(Jan. 1969). (In Russian).

Earlier studies on electron scattering at 180° by ^{23}Na and ^{39}K revealed several excited levels of ^{23}Na; however, in view of the low sensitivity of electrons scattered at 180° with respect to the longitudinal (Coulomb) excitation, it was not clear whether transversal electric or magnetic excitation was involved. A study was therefore undertaken to cover a wide range of scattering angles to determine the charge density distribution in the ground state and the Coulomb excitation of discrete energy levels. The experiments were carried out on the 300-MeV electron accelerator of the Institute, using a magnetic spectrometer to analyze the electron scattering pulses recorded by a Cherenkov counter; natural Na and K served as targets. "Uniform–uniform," "uniform–Gaussian," and "shell" models were used to evaluate the elastic scattering results for angles ranging from 20° to 125°. For the inelastic scattering data, a "model-dependent" and a "model-independent" method was used. (TTT)

42877 STUDY OF THE LEVELS OF ^{24}Mg BY MEANS OF ELECTRON SCATTERING. Savitskii, G. A.; Afanas'ev, N. G.; Andreeva, I. V.; Gul'karov, I. S.; Krugovaya, L. M.; Khvastunov, V. M.; Khomich, A. A.; Shevchenko, N. G. (Physical-Technical Inst., Kazan). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 53-9(Jan. 1969). (In Russian).

The higher levels of ^{24}Mg and the elastic and inelastic scattering resulting in the excitation of the 1.37-MeV level were investigated using the 300-MeV electron accelerator of the Institute. Natural magnesium, containing 78.6% ^{24}Mg, 10.1% ^{25}Mg, and 11.3% ^{26}Mg, was used for the experiment. It was found that the inelastic scattering of neutrons by the ^{24}Mg nucleus causes excitation of certain levels. The most reliable data were obtained for the 1.37-, 6.0-, and 7.6-MeV levels; somewhat less certain values were also obtained for the 4.12-, 4.23-, and 6.9-MeV levels. The strong ($G \sim 20$) excitation of the 1.37(2^+)- and 6.0(4^+)-MeV levels is considered of special interest. An E1 transition was found in the 6.9 ± 0.3-MeV excitation energy range; it is considered similar to those found with ^{39}K and ^{32}S. The increase of the transition radius with increasing multipolar character of the transition originally observed by the authors for ^{28}Si was confirmed also in the case of ^{24}Mg. (TTT)

42878 THE HALF-LIFE OF THE SECOND EXCITED STATE IN ^{45}Ti. Biasi, P.; Maurenzig, P. R.; Taccetti, N. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cim., Lett., 2: 174-6(Aug. 1, 1969).

The half-life of the 40-keV level in ^{45}Ti was determined by measuring the time delay spectrum from the ^{45}Sc(p,nγ) reaction with a NaI(Tl) spectrometer. A value of 11.5 ± 1.5 ns was found. A comparison of the experimental value with the Weisskopf estimates gives a clear indication of the multipole character of the transition. (J.W.R.)

42879 MEASUREMENT OF THE MANGANESE ACTIVATION RESONANCE INTEGRAL USING THE MANGANESE BATH TECHNIQUE. Ryves, T. B.; Hunt, J. B.; Goodier, I. W. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy, 22: 465-70(Aug. 1968).

The reduced resonance integral of ^{55}Mn was measured by a new method, using a conventional manganese sulphate bath containing several known concentrations of boron and employing an extrapolation technique. A value of 5.7 ± 1.7 b was obtained relative to the 20 b scattering cross section of hydrogen. (auth) (UK)

42880 COULOMB EXCITATION OF ^{35}Cl PROJECTILES. Haeusser, O. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Pelte, D.; Alexander, T. K.; Evans, H. C. Can. J. Phys., 47: 1065-75(May 15, 1969). (AECL–3280).

Coulomb excitation of the first two excited states in ^{35}Cl was studied by bombarding thick foils of ^{24}Mg and carbon with ^{35}Cl ions of energies between 51 and 61 MeV. De-excitation gamma rays were observed in two 40 cm^3 Ge(Li) detectors. From absolute cross-section measurements the following B(E2) values were obtained, $B(E2, 0 \rightarrow 1220) = (0.081 \pm 0.009) \times 10^{-50}\ e^2\ \mathrm{cm}^4$ and $B(E2, 0 \rightarrow 1762) = (1.17 \pm 0.09) \times 10^{-50}\ e^2\ \mathrm{cm}^4$. The mixing ratio $\delta(1762 \rightarrow 0)$ was measured to be -2.95 ± 0.45 which can be combined with the corresponding B(E2) value to yield $\tau(1762) = (0.555 \pm 0.050)$ ps. A Doppler shift attenuation method was employed to interpret the observed gamma-ray lineshapes in terms of nuclear lifetimes. The lineshape analysis yielded $\tau(1220) = (0.16 \pm 0.05)$ ps and confirmed $\tau(1762)$ obtained from the absolute cross-section measurements. The results provide evidence that the three lowest states in ^{35}Cl cannot be interpreted by a weak coupling model. (auth) (Canada)

42881 MASS NUMBER DEPENDENCE OF THE LEVEL DENSITY PARAMETER IN (α,n) REACTIONS. Magda, M. T.; Plostinaru, D.; Trutia, Elena; Alevra, A.; Lukas, Ingrid R.; Molea, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 3-6(1969).

The dependence of level density parameter on mass number at various bombarding energies was studied from the energy distribution of the neutrons resulted in (α,n) reactions. An anomalous mass number dependence at the highest bombarding energy was observed, as well as a variation with the bombarding energy. (auth)

42882 POSITIVE PARITY STATES IN ^{40}K. Twin, P. J.; Olsen, W. C.; Wong, E. (Univ. of Alberta, Edmonton). Phys. Lett., 29B: 570-2(Aug. 4, 1969).

Neutron and γ-ray angular distributions, and γ-ray polarization correlations were measured with the reaction ^{40}Ar(p,nγ)^{40}K.

Positive parity states were established at 1.644 MeV (0^+), 1.959 MeV (2^+), 2.261 MeV (3^+) and 2.290 MeV (1^+). (auth)

42883 SHELL-MODEL APPROACH TO THE LOW-ENERGY SPECTRUM OF ^{59}Cu. Bouten, M.-C. (CEN-SCK, Mol, Belgium); Bouten, M.; Depuydt, H. Physica, 40: 213-22(Dec. 13, 1968).

A standard shell-model calculation was carried out for the low lying levels of ^{59}Cu. The three outer nucleons, outside the ^{56}Ni core, are allowed to move in the $1p^{3}/_{2}$, $0f^{5}/_{2}$ and $1p^{1}/_{2}$ single particle orbits. A conventional Gaussian interaction with exchange character is taken as residual interaction. Treating the strength of the interaction as a parameter, it is not possible to get agreement with experiment for any of the four exchange mixtures which we consider. The main discrepancy is found for the large $f^{5}/_{2}$ single particle strength observed in the excited level at 0.92 MeV. Repeating the calculation with the SDI and treating the triplet strength as a parameter, it becomes possible to obtain a satisfactory fit for all data if one assumes the 1.83- and 1.96-MeV levels to be due to configurations which are neglected in this calculation. (auth)

42884 HYPERFINE SPLITTING OF THE $3d^54s4p$ LEVELS OF Mn I AND THE QUADRUPOLE MOMENT OF ^{55}Mn. Handrich, E.; Steudel, A.; Walther, H. (Technische Univ., Hanover). Phys. Lett., 29A: 486-8(June 30, 1969).

The hyperfine structure of the $3d^54sp$ $z^6P_{3/2,5/2,7/2}$ levels of Mn I, investigated by the level crossing method, and also former experimental hyperfine results for other levels of $3d^54s4p$ are discussed. The quadrupole moment Q(^{55}Mn) = 0.40(2) b is derived. (auth)

42885 OPTICAL-MODEL ANALYSIS OF ELASTIC SCATTERING OF ^{3}He PARTICLES FROM ^{58}Ni AT 24.15, 27.64, AND 34.14 MeV. Fujisawa, T.; Kamitsubo, H.; Wada, T.; Igarashi, M. (Inst. of Physical and Chemical Research, Yamato, Japan). J. Phys. Soc. Jap., 27: 278-90(Aug. 1969).

The elastic scattering of ^{3}He particles from ^{58}Ni at 24.15, 27.64, and 34.14 MeV was studied. The measurements were done at laboratory angles extending from 15° to 170° at 2.5° or 5° intervals. An optical-model analysis was carried out with an automatic search code. Both Woods–Saxon potential and derivative Woods–Saxon potential were applied to the imaginary part of the optical potential. The latter gave better fit than the former at backward angles when a spin–orbit coupling potential was not used. An analysis using the optical potential with Thomas-type spin–orbit coupling was also carried out. The depth of spin–orbit coupling potential depends on the depth of the real potential and the different potentials that minimize X^2/N for the cross section give similar polarizations. Ambiguities in the optical-model parameters appear in all the analyses. (auth)

42886 THE GROUND-STATE TRANSITION WIDTH OF THE 7368-keV LEVEL OF ^{66}Zn. Shikazono, Naomoto; Kawarasaki, Yuuki (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap., 27: 273-7(Aug. 1969).

A nuclear resonant scattering experiment was carried out using the lead capture gamma rays on natural zinc. The ground-state transition width of the 7368-keV resonance level was measured by means of self-absorption and temperature variation. The width Γ_0 and the separation energy between source and target levels δ were found to be 0.22 ± 0.02 eV and 8.5 ± [illegible] eV, respectively. (auth)

42887 MEAN LIVES OF STATES IN ^{29}Si BELOW 5 MeV. Wozniak, M. J. Jr.; Hershberger, R. L.; Donahue, D. J. (Univ. of Arizona, Tucson). Phys. Rev., 181: 1580-5(May 20, 1969).

The Doppler-shift attentuation method was used to obtain the following information concerning the mean lives of the low-lying states in ^{29}Si: τ(1.27-MeV) = (3.7± [illegible]) × 10^{-13} sec, τ(2.03-MeV) = (3.7± [illegible]) × 10^{-13} sec, τ(2.43-MeV) ≤ 4.6 × 10^{-14} sec, τ(3.07-MeV) ≤ 7.4 × 10^{-14} sec, τ(3.62-MeV) = (4.8± [illegible]) × 10^{-12} sec, τ(4.08-MeV) = (7 ± 2) × 10^{-14} sec, τ(4.84-MeV) ≤ 1.3 × 10^{-14} sec. The results of a series of measurements to test the calculation of the unattenuated Doppler shift are reported. Some information concerning the branching ratios of the states at 4.84, 4.89, and 4.93 MeV in ^{29}Si is also presented. A value of $^{7}/_{2}{}^{+}$ is suggested for the spin and parity of the 4.08-MeV state. Some of the results are compared to a simple pure-rotational-model interpretation of ^{29}Si. (auth)

42888 NUCLEAR STRUCTURE OF ^{88}Sr AND ^{89}Sr. Hughes, T. A. (IBM Scientific Center, Houston, Tex.). Phys. Rev., 181: 1586-96(May 20, 1969).

A theoretical study of the positive-parity states in ^{88}Sr and ^{89}Sr was performed using phenomenological two-body matrix elements. In ^{88}Sr, two uncoupled spaces were considered. In the first, the $p_{3/2}$, $p_{1/2}$, $f_{5/2}$, and $f_{7/2}$ proton orbitals were used to describe the possible excitations. In the second, neutron-neutron-hole states were calculated. Positive-parity levels in ^{89}Sr were calculated using configurations formed by the coupling of one neutron to the proton states discussed above. The configurational makeup of the ground state, the E2 transition rate of the 1.85-MeV level, and other structure properties are discussed for ^{88}Sr. Spectra, stripping and nonstripping levels, and (p,p′) and (p,γ_0) analog-state reactions are considered in the ^{89}Sr model. (auth)

42889 DECAY SCHEME OF THE 23-Min ^{60}Cu WITH HIGH-RESOLUTION Ge(Li) DETECTORS. Hoffman, E. J.; Sarantites, D. G. (Washington Univ., St. Louis). Contract Nos. AT(11-1)-1530; AT(11-1)-1760. Phys. Rev., 181: 1597-1605(May 20, 1969).

The decay of the 23-min ^{60}Cu was investigated with the use of Ge(Li) and NaI(Tl) γ-ray detectors. Coincidence relationships among the γ rays were established in γ-γ coincidence experiments. It was concluded that the decay of the 23-min ^{60}Cu populates levels at 1332.4, 2158.8, 2284.4, 2505.6, 2626.0, 3124.2, 3194.2, 3269.3, 3393.4, 3735.8, 4003.4, 4022, 4078.6, 4317, 4494, 4548, and 4573 keV. A number of transitions not reported previously have been observed and assigned in the decay scheme. The levels populated in the proposed decay scheme have been previously reported from studies of the ^{60}Cu decay and from nuclear-reaction spectroscopic studies. From log ft values and γ-ray information, many spin assignments have been made. The levels are compared with the results of recent calculations on current models for the nucleus. No evidence is found for a 0^+ state at about 2.9 MeV as predicted by the effective-interaction calculations based on the shell model. (auth)

42890 LIFETIMES OF EXCITED STATES IN ^{40}Ca BY THE DOPPLER-SHIFT ATTENUATION METHOD. Poletti, A. R.; Jones, A. D. W.; Becker, J. A.; McDonald, R. E. (Lockheed Research Lab., Palo Alto, Calif.). Phys. Rev., 181: 1606-17 (May 20, 1969).

Lifetimes of levels in ^{40}Ca below an excitation energy of 6.3 MeV were studied through the ^{40}Ca(p,p′γ)^{40}Ca reaction. Bombarding energies between 8.5 and 9.0 MeV were used. Gamma-ray spectra were recorded with a Ge(Li) spectrometer at angles between θ_γ = 0° and θ_γ = 120° using targets of thick metallic calcium as well as calcium foils prepared by evaporation. From these measurements, accurate excitation energies and γ-ray decay modes were determined for the levels below 6.3-MeV excitation energy, information on level spin parity was deduced, and values or limits for the mean lifetimes of the levels were extracted from observations of γ-ray Doppler shifts. The existence of two close-lying levels with excitation energies 6025.2 ± 0.4 and 6029.0 ± 0.5 keV was established. Recent results obtained elsewhere confirm the existence of this doublet. Upon combining our results with previously available information, we deduce the following lifetimes [E_{expt}(MeV); τ_m(psec)] for a number of levels of ^{40}Ca: 5.212(1.9 ± 0.3), 5.249(0.18 ± 0.03), 5.279(0.33 ± 0.08), 5.615(0.85 ± 0.20), 6.025(0.22 ± 0.03), 6.029 (0.47 ± 0.13), and 6.285(0.45 ± 0.10). In view of the decay modes established for the doublet at 6.027 MeV, we have reanalyzed previously published work to obtain, in conjunction with the lifetime measurement, a rigorous spin-parity assignment of $J^\pi = 3^+$ for the 6.029-MeV level. The measured M1 and E2 radiative widths for the transitions among the 5^-, 4^-, 3^-, and 2^- states at 4.492, 5.615, 3.737, and 6.025 MeV are compared to calculations in which these levels are identified as belonging to the $d_{3/2}^{-1}f_{7/2}$ configuration. Calculated decay modes of the 4^-, T = 1 level at 7.659 MeV are compared to experiment. (auth)

42891 LOW-LYING STATES IN ^{86}Rb FROM (d,p), (d,t), AND (n,γ) REACTIONS. Dawson, J. W.; Sheline, R. K. (Florida State Univ., Tallahassee). Contract Nos. W-7405-Eng. 36; AT(40-1) 2434; AT(40-1)3235. Phys. Rev., 181: 1618-30(May 20, 1969).

The energy levels of ^{86}Rb were studied through the neutron stripping and pickup reactions ^{85}Rb(d,p)^{86}Rb and ^{87}Rb(d,t)^{86}Rb, and the thermal-neutron-capture reaction ^{85}Rb(n,γ)^{86}Rb. Enriched targets were bombarded with 12-MeV deuterons, and proton and triton spectra were observed with a magnetic spectrograph; proton angular distributions were compared with a distorted-wave Born-approximation (DWBA) calculation. Thermal-neutron-capture γ-ray spectra from both enriched ^{85}Rb and natural rubidium targets were studied in the energy intervals 50 to 2000 keV and 5000 to 8500 keV with a Ge(Li) spectrometer system. 32 low-energy γ-ray transitions were incorporated into a level scheme defined by the combined (d,p), (d,t), and the primary (n,γ) measurements. Tentative spin and parity assignments for 18 levels below 1505 keV are proposed on the basis of assigned orbital angular momentum transfers and γ-ray population and decay modes. The low-lying states of ^{86}Rb are discussed in terms of shell-model proton-neutron configurations; comparison is made with a zero-range spin-dependent calculation. Although correlation between the data and positive parity levels predicted by the simple model is not entirely satisfactory, reasonable agreement has been found for low-lying negative parity levels. (auth)

42892 BETA DECAY OF ^{24}Ne. McDonald, R. E.; Becker, J. A.; Jones, A. D. W.; Poletti, A. R. (Lockheed Research Labs., Palo Alto, Calif.). Phys. Rev., 181: 1631-3(May 20, 1969).

The β decay of ^{24}Ne was studied by observing the delayed γ-ray spectrum with the aid of a Ge(Li) γ-ray spectrometer. ^{24}Ne was produced by the ^{22}Ne(t,p)^{24}Ne reaction, at an incident bombarding energy of 2.5 MeV. Two strong γ rays attributable to the β decay of ^{24}Ne were observed, with energies $E_\gamma = 472.2 \pm 0.2$ and 874.3 ± 0.3 keV; these are assigned to the $0.472 \rightarrow 0$ and $1.347 \rightarrow 0.472$ transitions in ^{24}Na, respectively. Both β-decay modes are allowed; thus $J^\pi = (0,1)^+$ for the ^{24}Na 0.472- and 1.347-MeV levels. For both these levels, the spin-parity assignment $J^\pi = 1^+$ follows immediately from the allowed nature of the β transitions and the isotopic spin selection rule: If $\Delta T = 1$, the $0^+ \rightarrow 0^+$ β transition is forbidden. The spin-parity of the 1.347-MeV level had previously been unknown. (auth)

42893 PROTON POLARIZATION NEAR THE J-DEPENDENT CROSS-SECTION MINIMUM IN THE ^{40}Ca(d,p)^{41}Ca*(3.95 MeV) REACTION. Foster, C. C.; Maddox, W. E.; Miller, D. W. (Indiana Univ., Bloomington). Phys. Rev., 181: 1529-36(May 20, 1969).

Using incident deuterons with energy E_d of 11.0 MeV, the polarization of protons from the ^{40}Ca(d,p) reaction leading to the 3.95-MeV state of ^{41}Ca was measured at three angles across the J-dependent minimum in the cross-section angular distribution near $\theta_{cm} = 100°$. A 180° double-focusing magnetic spectrometer focused the proton group under investigation into a carbon polarimeter. The use of three dE/dx and two E solid-state detectors connected in two parallel triple-coincidence configurations kept the background below 4%, even though the cross section was very low (240 μb/sr). The measured polarization passes smoothly through zero near the cross-section minimum as follows: -0.128 ± 0.039, $+0.061 \pm 0.046$, and $+0.151 \pm 0.041$ at laboratory angles of 84.2°, 97.1°, and 110.0°, respectively. Cross-section angular distributions for ^{40}Ca(d,p) reactions to the ground, 1.95-, 2.47-, and 3.95-MeV states in ^{41}Ca and for elastic deuteron scattering with $E_d = 10.96 \pm 0.03$ MeV were also measured. Discrepancies of about 25% exist between these distributions and those of Lee et al. (auth)

42894 STRIPPING CROSS-SECTION CALCULATIONS: COMPARISON BETWEEN A COUPLED-CHANNEL METHOD AND THE DWBA FOR ^{40}Ca. Rawitscher, George H.; Mukherjee, Shankar N. (Univ. of Connecticut, Storrs). Phys. Rev., 181: 1518-28(May 20, 1969).

Deuteron-stripping differential cross sections are calculated by a coupled-channel (C.Ch.) method and compared to distorted-wave Born-approximation (DWBA) results for incident energies of 2, 4, 5, 7, and 11 MeV. The reaction envisaged is ^{40}Ca(d,p)^{41}Ca to a 2p state in ^{41}Ca. The optical-model deuteron potential employed in the DWBA calculation is such that for each energy the elastic deuteron cross section reproduces the C.Ch. result as closely as possible. It is found that the maxima of the stripping cross sections are within 10% of each other for energies above 2 MeV. This good agreement does not occur for stripping to 1f states, the DWBA result being larger than 40% or more. However, in this case the C.Ch. calculation is only approximate, since the coupling of the f-stripping channel to the deuteron channel is not explicitly included in the calculation. Various other quantities are defined and evaluated in order to illustrate the differences between the C.Ch. and DWBA calculations. They are the "trivially equivalent deuteron potential," the stripping emission density, and an average of the absolute value squared of the radial stripping overlap integrals. The integrand of the latter quantity is also plotted for some cases. (auth)

42895 NUCLEAR ENERGY LEVELS OF ^{51}V, ^{53}Mn, AND ^{55}Co BY THE QUASIPARTICLE METHOD. Raj, Ram; Rustgi, M. L.; Singh, R. P. (State Univ. of New York, Buffalo). Phys. Rev., 181: 1536-40(May 20, 1969).

The modified Tamm–Dancoff approximation was applied to the calculation of the nuclear energy levels of ^{51}V, ^{53}Mn, and ^{55}Co. The shell-model reaction matrix elements of Kuo and Brown, calculated with the Hamada–Johnston nucleon–nucleon potential and renormalized for core polarization, are used with the aim of ascertaining the accuracy of these matrix elements. The effects of the extra term in the BCS equations and of the ground-state correlation are studied. Only a qualitative agreement between theoretical and experimental spectra is found for all three nuclei investigated. (auth)

42896 LEVEL ORDER IN ^{22}Ne, ^{24}Mg, AND ^{26}Mg: INFERENCE ON THE EFFECTIVE INTERACTION. Abulaffio, Carla (Technion-Israel Inst. of Tech, Haifa). Phys. Rev., 181: 1541-3 (May 20, 1969).

It has been found that the experimental order of the low levels in ^{22}Ne, ^{24}Mg, and ^{26}Mg can be reproduced by a residual interaction which has the "correct" amount of Majorana exchange. The dependence of the level order on the range appears to be different for the three nuclei. A change of range is more effective on the spectra for a Gaussian than for a Yukawa interaction. (auth)

42897 LIFETIME OF THE 3.19-MeV(6^+) STATE IN ^{42}Ca Mendelson, R. A.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Phys. Rev., 181: 1552-5(May 20, 1969).

The lifetime of the (6^+) 3.19-MeV state in ^{42}Ca was measured by obtaining the time distribution of coincidences between positrons forming the state, from the decay of the (7^+) 615-keV state in ^{42}Sc, and 440-keV-decay γ rays. The metastable (61-sec) state in ^{42}Sc was generated by the ^{40}Ca(^{3}He,p)^{42}Sc reaction using a 6.10-MeV ^{3}He beam from the University of Iowa Van de Graaff. A 60-sec beam-on-beam-off cycle was employed. Positrons were detected by a 2-in.-diam × 1-in.-high plastic scintillator, and γ rays by a 1-in. × 1-in. NaI(Tl) scintillator. Both scintillators were viewed by RCA-8575 photomultipliers whose dynodes were gated to avoid damage during the beam-on time. The value obtained for the mean lifetime was $(7.72 \pm 0.26) \times 10^{-9}$ sec which corresponds to a $B(E2, 6_1^+ \rightarrow 4_1^+) = (6.40 \pm 0.22)\ e^2F^4$. This value may be compared with the (2^+) 1.52-MeV to (0^+) ground-state decay, assuming both represent transitions between $f_{7/2}^2$ states. The result indicates that collective admixtures in the 0_1^+ and 2_1^+ wave functions are larger than for the 6_1^+ and 4_1^+ levels. This can be understood quantitatively if one considers the low-lying levels in ^{42}Ca to be shell-model states mixed with rotational states arising from 4p–2h excitation according to a recent model by Gerace and Green. (auth)

42898 LIFETIME AND ANGULAR DISTRIBUTION MEASUREMENTS FROM THE ^{31}P(p,γ)^{32}S REACTION. Piluso, C. J.; Salzman, G. C.; McDaniels, D. K. (Univ. of Oregon, Eugene). Phys. Rev., 181: 1555-64(May 20, 1969).

The ^{31}P(p,γ)^{32}S reaction was studied at several resonances with a 20-cm^3 Ge(Li) detector. A level at 6.664 MeV was populated which may be the same as one found at 6.671 MeV from (^{3}He,d) experiments. This state is found to branch almost equally to the states at 3.775 and 2.230 MeV. Measured branching ratios for the first six excited states are in agreement with earlier work except for a ground-state transition for the 5.006-MeV level which supports an odd-parity assignment for this state. New branching ratios are assigned for the levels at 5.544 and 6.673 MeV. Doppler-shift lifetime measurements for the states at 3.775, 4.280, 4.694, 5.006, 5.410, 5.544, 6.226, and 6.623 MeV are consistent with other measurements. The lifetime of the level at 6.664 MeV is found to be $0.054^{+0.013}_{-0.008}$ psec. An upper limit of 0.01 psec is set for the mean life of the 7.952-MeV level. Angular distributions were measured with the Ge(Li) detector for the 1.248- and 1.438-MeV resonances. Spins deduced from combining these results with the lifetime measurements confirm previous assignments for levels at 6.623, 6.226, and 5.410 MeV. The spin of the 4.459-MeV level is limited to 3 or 4, consistent with other recent work and with the hypothesis of Goswami et al., that this is the 4^+ level of a rotational band based on the 0^+ ground state. Mixing ratios are given for a number of transitions. (auth)

42899 EXCITATION FUNCTIONS OF DEUTERON INDUCED REACTIONS. Nishi, Tomota (Kyoto Univ.); Otozai, Kiyoteru. Bull. Inst. Chem. Res., Kyoto Univ., 47: 162-75(Mar. 1969).

Excitation functions of reactions induced by deuterons on ^{142}Ce, ^{130}Te, ^{96}Zr, and ^{70}Ge were measured with the activation method up to 14.1-MeV deuteron energy. The observed reactions are (d,p), (d,n), (d,2n) and/or (d,3n), and (d,α) reactions on each target. The results are well explained with a modified Peaslee theory on deuteron reactions, in which a new parameter, "entire absorption," is introduced. Excitation functions of ^{142}Ce, ^{130}Te, and ^{96}Zr give the common values of variable parameters and a common pattern regarding relative contributions of neutron stripping, proton stripping, and entire absorption processes. The situation is quite different for ^{70}Ge. (auth)

42900 EXCITATION ENERGIES AND LIFETIMES OF LEVELS IN ^{26}Si. Bell, R. A. I.; L'Ecuyer, J.; Gill, R. D.; Robertson, B. C.; Towner, I. S.; Rose, H. J. (Nuclear Physics Lab., Oxford). Nucl. Phys., A133: 337-56(1969).

Measurements of excitation energies, lifetimes, and decay modes in ^{26}Si are described. The ^{24}Mg(^{3}He,n)^{26}Si reaction was used. The following energies and lifetimes were determined: 1795.9 ± 0.2 keV ($\tau = 1.4^{+0.7}_{-0.5}$ ps); 2783.5 ± 0.4 keV ($\tau = 0.20^{+0.10}_{-0.12}$ ps); 3332.5 ± 0.3 keV ($\tau = 2.7^{+1.3}_{-0.8}$ ps); 3756 ± 2 keV ($\tau < 0.7$ ps); 3842 ± 2 keV; 4093 ± 3 keV; 4138 ± 1 keV ($\tau = 0.11^{+0.11}_{-0.06}$ ps); 4445 ± 3 keV ($\tau < 0.5$ ps); and 4805 ± 2 keV ($\tau < 0.1$ ps). These results are compared to shell-model calculations. (auth)

42901 DECAY OF $^{62}_{29}$Cu$_{33}$. Jongsma, H. W.; Bengtsson, B.; Dulfer, G. H.; Verheul, H. (Vrije Univ., Amsterdam). Physica, 42: 303-8(Apr. 21, 1969).

The gamma-ray spectrum following the decay of ^{62}Cu was measured with Ge(Li) detectors. The measured energies and relative intensities of the gamma rays are: $\gamma^{\pm}$ (196.4%); 0.8757 MeV (0.12%); 1.130 MeV (0.016%); 1.1736 MeV (0.26%); 2.303 MeV (0.041%). A mass-separated source was used for half-life measurements and assignments. The half-life was measured to be (9.73 ± 0.02) min. The branching ratio of the second 2^+ level in ^{62}Ni has been compared with recent theoretical calculations. (auth)

42902 ENERGY LEVELS OF ^{56}Fe: THE ^{56}Fe(n,n'γ)^{56}Fe REACTION AND THE γ-SPECTRUM OF ^{56}Co. Armitage, B. H. (Atomic Energy Research Establishment, Harwell, Eng.); Ferguson, A. T. G.; Neilson, G. C.; Pritchard, W. D. N. Nucl. Phys., A133: 241-54(1969).

Relative intensities for the production of γ rays by inelastic neutron scattering from iron were measured at 90° with 4.3-MeV and 5.3-MeV neutrons. The gamma radiations following the decay of ^{56}Co to ^{56}Fe were also measured. In each case, the γ rays were detected with a Ge(Li) spectrometer of about 30 cm^3 in volume. On the basis of these two measurements, a decay scheme was constructed which has a good measure of agreement with the level positions and spins obtained by McGrory in a shell-model calculation of the energy levels of ^{56}Fe. (auth)

42903 THE STATIC QUADRUPOLE MOMENT OF THE FIRST EXCITED STATE OF ^{60}Ni. Cline, D.; Gertzman, H. S.; Gove, H. E.; Lesser, P. M. S.; Schwartz, J. J. (Univ. of Rochester, N. Y.). Nucl. Phys., A133: 445-64(1969).

From measurements of the Coulomb excitation of the 1.3325-MeV first-excited state in ^{60}Ni using sulfur and oxygen ions, it has been possible to obtain a value for the static quadrupole moment of this state. Analysis of the data using a coupled-channel computer code yields the results: $B(E2; 0^+ \rightarrow 2^+) = 0.0914 \pm 0.0020$ $(e \cdot b)^2$ and a first excited state static quadrupole moment of $Q = 0.00 \pm 0.13\ e \cdot b$. These results are in good agreement with both microscopic- and macroscopic-model predictions. Uncertainty in the signs of the interference terms due to virtual excitation through higher excited 2^+ states contributed 40% of the error assigned to Q. The ^{16}O scattering data deviated markedly from Coulomb excitation theory for incident energies above 30 MeV presumably due to the occurrence of nuclear interactions. These deviations were indistinguishable from those produced by the reorientation effect assuming a large negative static quadrupole moment for the first excited state. (auth)

42904 ISOBARIC ANALOGUE STATES IN ^{73}As. Betigeri, M. G.; Lamba, C. M.; Sarma, N.; Sood, D. K.; Thampi, N. S. (Bhabha Atomic Research Centre, Bombay). Nucl. Phys., A133: 465-72(1969).

States have been observed in the compound nucleus ^{73}As through the study of elastic scattering of protons on ^{72}Ge which are the isobaric analogs of the low-lying levels of ^{73}Ge. The excitation functions cover the first five levels. Two of these, being l = 4 transitions, are not observed in the study because of the low barrier transmission. l-values have been assigned to the states from the analysis of the differential cross sections. The results are compared with available evidence from other experiments on ^{73}Ge. (auth)

42905 THE ^{60}Ni(d,n) REACTION ABOVE AND BELOW THE COULOMB BARRIER AND THE DEUTERON OPTICAL-MODEL POTENTIAL. Fuchs, H.; Grabisch, K.; Roeschert, G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys., A133: 385-99(1969).

Neutrons from the deuteron bombardment of ^{60}Ni were investigated with the time-of-flight method. Angular distributions were obtained at 6 and 3.8 MeV bombarding energies. The differential cross sections at E_d = 6 MeV are analyzed with DWBA to yield l-values and spectroscopic factors. These are compared to previous measurements and to weak-coupling predictions. From the differential cross sections of the ground-state transition, deuteron optical-model potentials are evaluated for 6 and 3.8 MeV bombarding energies by means of a DWBA search procedure. It is shown that the (d,n) reaction allows a determination of the deuteron potential at subcoulombic energies, where the elastic scattering may not be used for this purpose. (auth)

42906 g-FACTORS FOR 2^+ STATES OF DOUBLY EVEN NUCLEI. (Ge, Se, Mo, Ru, Pd, Cd, AND Te). Heestand, G. M. (Univ. of Wisconsin, Madison); Borchers, R. R.; Herskind, B.; Grodzins, L.; Kalish, R.; Murnick, D. E. Nucl. Phys., A133: 310-20(1969).

The gyromagnetic ratio, g, for the first excited 2^+ states of 25 even-even isotopes of Ge, Se, Mo, Cd, Pd, Ru, and Te were obtained using the ion implantation perturbed angular correlation technique. The g factors were extracted from the measured precession angles using known lifetimes, equilibrium hyperfine magnetic field values, and transient hyperfine magnetic field data for fast ions in ferromagnetic lattices. The results indicate that the g factors vary little for the states studied, and are close to the collective value Z/A. (auth)

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Refer also to abstracts 40631, 41042, 41049, 42508, 42558, 42710, 42793, 42854, 42861, 42881, 42899, 42906, 42960, 42965, and 42969.

42907 (ANL-Trans-746) PERSPECTIVES IN THE SYNTHESIS OF NEW ISOTOPES AND ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translation of report JINR-P7-4199. 30p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 13262.

42908 (ANL-Trans-747) MASS DISTRIBUTION OF THE FISSION FRAGMENTS OF THE BISMUTH AND URANIUM NUCLEI BY HEAVY IONS. Karamyan, S. A.; Normuratov, F.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E.; Pustylnik, B. I.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translation of report JINR-P7-3732. 14p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 24857.

42909 (CEA-R-3776) PARTIAL RADIATIVE CAPTURE OF RESONANCE NEUTRONS. Samour, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1969. 244p. (In French). Dep.

The radiative capture of resonance neutrons was studied between 0.5 and 700 eV with the time-of-flight method and a Ge(Li) detector. ^{195}Pt + n and ^{183}W + n allow analysis of the distribution of partial radiative widths and their eventual correlation and also the variation of $< \Gamma\gamma_i >$ with $E\gamma$. The mean values of M1 and E1 transition intensities are compared in several tin isotopes. Interference effects, either between resonances or between direct capture and resonant capture were found in ^{195}Pt + n, ^{197}Au + n and ^{59}Co + n. The excited level schemes of a great deal of nuclei were obtained and compared with theoretical predictions. (auth)

42910 (CONF-670109-10) MEASUREMENTS ON THE DECAY OF ^{197}Hg. Bartlett, A. A.; Bulthaup, D.; Mohan, K. (Colorado Univ., Boulder). [nd]. 12p. Dep. CFSTI.

From Annual Meeting of the American Physical Society, New York.

The internal and external conversion spectra of ^{197}Hg were studied with a high-resolution beta spectrometer. The internal conversion sources were prepared using the "COLUTRON" mass separator, and with these sources it was possible to resolve conversion lines as far as the N subshells for some of the stronger transitions. In particular, for the 191-keV transition, K; $L_T : M_T$; N + 0 = 100; 19.1 ± 1; 5.76 ± 0.3; 1.51 ± 0.2 and L_I; L_{II}; L_{III} = 100; 9.5 ± 0.4; 2.69 ± 0.4. The i.c.c. of the 191-keV transition was compared with that of the 279-keV transition in ^{203}Hg by an I.E.C. method. The E.C. spectrum of conversion in tin and in cadmium was studied in order to determine the intensity of the 77-keV nuclear transitions relative to the K x-rays following conversion and K capture. Tentative results for the intensities are $K_{\alpha 1}$; $K_{\alpha 2}$; $K_{\beta 1}$; $K_{\beta 2}$; $K_{\beta 3}$; 77 keV = 100; 51.9; 25.8; 8.8; 13.2; 61.9. Detailed results on other transitions will be presented. The measurement program is continuing. (auth)

42911 (JINR-D6-4554) CONFIRMATION OF THE EXISTENCE OF LONG-LIVED SPONTANEOUSLY FISSIONING NATURAL EMITTER. Flerov, G. N.; Skobelev, N. K.; Ter-Akop'yan, G. M.; Subbotin, V. G., Gvozdev, B. A.; Ivanov, M. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 12p. (In Russian). Dep.

Using large proportional counters, the spontaneous fission in samples of lead glasses and natural minerals (galenas) was observed. For two samples of glass the measured spontaneous fission half-life referred to lead was found to be $(4.4 \pm 1.0) \times 10^{20}$ years. The effect observed cannot be explained by spontaneous fission of the uranium impurity or by induced fission of lead and thorium. Analogous results were obtained also for two samples of galena. The experimental data presented prove the hypothesis of the existence of long-lived spontaneously fissioning nuclei. (auth)

42912 (LA-4198) FISSION BARRIERS AND TRANSITION-STATE SPECTRA FOR ^{232}Th, ^{234}Th, ^{238}U, ^{240}U, ^{242}Pu, AND ^{244}Pu FROM (t,pf) REACTIONS. Cramer, James D. (Los Alamos Scientific Lab., N. Mex.). June 12, 1969. Contract W-7405-eng-36. 109p. Dep. CFSTI.

Fission probabilities and the angular distribution of the fission fragments were measured for six even-even compound-nucleus systems using the (t,pf) reaction. Angular correlations of fission fragments obtained in these experiments provide information about the low-lying collective excitations or transition states at the fission barrier. The (t,p) reaction in particular leads to neutron-rich residual nuclei unobtainable by other methods. The absence of spin coupling for (t, p) reactions on even-even targets provides angular distributions with well-defined structure in the region of the fission barrier. The experimental data were obtained using an 18-MeV triton beam on targets of ^{242}Pu, ^{240}Pu, ^{238}U, ^{236}U, ^{232}Th, and ^{230}Th at the Los Alamos Van de Graaff accelerator facility. Outgoing protons were detected at 140° relative to the incident triton beam. Excitation energies ranging from 3.0 to 9.0 MeV were obtained in these experiments. Fission fragment angular distributions were measured at 24 angles from 0° to 140° relative to the kinematic recoil angle. The data were fitted to a series of even Legendre polynomials $W(\theta) = A_0[1 + \Sigma_L g_L P_L (\cos\theta)]$ and the coefficients g_2 through g_{12} and A_0 were determined as a function of excitation energy. The fission probability P_f was obtained from the ratio of A_0 to the (t,p) cross section for the target nucleus. The results exhibit well defined structure in the angular coefficients which correlates with structure in the fission probability for most of the nuclei studied. In an attempt to interpret this observed structure, the experimentally determined fitting parameters P_f and g's are compared to calculated results of a microscopic model. This model takes into consideration the penetrability and angular dependence of fission through each member of the various transition bands at the saddle point and appropriately sums the results for comparison with the data. The effects of barrier penetration through a two-peaked deformation potential are incorporated into this analysis. Characteristics of transition-state spectra and fission barrier shapes determined from this analysis are presented with respect to variations of the fissility parameters. This survey of the fission properties of several nuclei indicates some general trends relating the saddle point deformation to the character of the transition level structure. (auth)

42913 (ORNL-TM-2599) POLLA: A FORTRAN PROGRAM TO CONVERT R-MATRIX-TYPE MULTILEVEL RESONANCE PARAMETERS FOR FISSILE NUCLEI INTO EQUIVALENT KAPUR-PEIERLS-TYPE PARAMETERS. de Saussure, G.; Perez, R. B. (Oak Ridge National Lab., Tenn.). June 12, 1969. 40p. Dep. CFSTI.

The program POLLA converts a set of R-matrix resonance parameters for fissile nuclei into an equivalent set of Kapur-Peierls parameters. The program utilizes the multilevel formalism developed by Reich and Moore and avoids the diagonalization of the level matrix, hence, it is particularly useful where many levels and few fission channels are involved. Some applications of the program are given and a FORTRAN listing is given in an appendix. 34 references. (auth)

42914 (ORNL-tr-2043) DECAY OF PHOTONEUTRONS PRODUCED BY THE GAMMAS OF THE FISSION PRODUCTS OF ^{235}U IN HEAVY WATER. Winter, Heinz; Deledicq, Helen (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-N-915. 19p. Dep. CFSTI.

The decrease of photoneutron emission after ^{235}U fission was calculated directly from the decay of the gamma spectrum of the fission products. The calculations were performed for the case of thermal fission in an infinite heavy-water medium, and for fission in the high-flux reactor core. The total yield of photoneutrons calculated for fission in the infinite heavy-water medium was lower than the experimental value. (J.W.R.)

42915 (ORO-2972-87) NUCLEAR STRUCTURE STUDIES FROM PROTON AND DEUTERON INDUCED REACTIONS ON ^{136}Xe. Technical Report No. 5. Moore, P. A.; Riley, P. J.; Jones, C. M.; Mancusi, M. D.; Foster, J. L. (Texas Univ., Austin. Center for Nuclear Studies). Oct. 1968. 261p. Dep. CFSTI.

Proton and deuteron induced reactions on ^{136}Xe were analyzed to obtain nuclear structure information for the ^{135}Xe, ^{136}Xe, and ^{137}Xe isotopes. Isobaric analogue resonances in the proton elastic excitation functions were fitted using the shell model approach to reaction theory to extract quantitative nuclear structure information for the parent analogue states in ^{137}Xe. The results of the elastic analysis are compared with a DWBA analysis of the ^{136}Xe(d,p)^{137}Xe angular distributions and the two analyses are found to be in excellent agreement. In all, 24 levels of ^{137}Xe were identified in the combined analyses, and spins, parities, and spectroscopic factors were determined for many of these states. A DWBA analysis of the ^{136}Xe(d,t)^{135}Xe angular distributions was also carried out, providing information on the structure of three levels of the ^{135}Xe nucleus. Thirty-six levels of ^{136}Xe were identified in the proton inelastic scattering data. The inelastic excitation functions for many of these states exhibit a resonant behavior characteristic of neutron particle-neutron hole excited states. The experimental inelastic proton angular distributions for the particle-hole states at the first ($f_{7/2}$), second ($p_{3/2}$), and fourth ($f_{5/2}$) analogue resonances were fit to determine the hole structure of the particle-hole configurations. Using the results of this analysis in conjunction with the resonant behavior of the corresponding inelastic excitation functions, it was possible to determine the particle-hole configurations of, and arrive at spin assignments for, several of the states of ^{136}Xe. (auth)

42916 (UR-3591-10) NUCLEAR REACTION MECHANISMS. Progress Report, May 1, 1968–May 1, 1969. Blann, Marshall (Rochester Univ., N. Y. Dept. of Chemistry). Contract AT-(30-1)-3591. 19p. Dep. CFSTI.

CADMIUM-104—electron-capture decay of, γ spectra for, (E)
NUCLEAR REACTIONS—mechanisms for, research at University of Rochester Chemistry Dept. from May 1, 1968 to May 1, 1969
PALLADIUM-104—proton inelastic scattering by, proton spectra for, (E)
—energy levels from rhodium-104 and silver-104 decays, (E)
RHODIUM-104—beta decay of ground-state and isomeric, γ spectra for, (E)
RUTHENIUM-93—beta decay of, γ spectra for
SILVER-104—beta and electron-capture decay of ground-state and isomeric, γ spectra for, (E)
—energy levels from cadmium-104 decay, (E) (J.W.R.)

42917 THE EFFECT OF THE ELECTRON SHELL ON THE γ RADIATION OF NUCLEI. Krutov, V. A.; Fomenko, V. N. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 84-7(Jan. 1969). (In Russian).

The γ radiation and internal conversion processes were examined on the basis of combined equations describing the amplitude of the nucleus–electron shell systems and containing matrix elements for the emission and absorption of photons and wave functions of the nucleus and the electron, and Rose's internal conversion coefficients. The equation system was solved by means of perturbation theory, considering only the ground and excited electron states and two nuclear states, neglecting nonresonance processes. By solving the system up to the third order of relative amplitudes and retaining the nonresonance terms, an expression was obtained for calculating the γ quanta emitted by the excited nucleus–electron shell system. The contribution of nonresonance processes to the γ emission probability was studied for 3 nuclear transitions: the E3 transition in the ^{124}Sb nucleus with an energy of $\omega = 18.5$ keV; the E2 transition in ^{238}Pu with $\omega = 44$ keV; and the E3 transition in ^{235}U with 75 or 23 eV. The calculations indicated that the effect of the nonresonance processes is very small. (TTT)

42918 STUDY OF $^{162}_{67}$Ho$_{95}$. Akhmed, M. R.; Baskova, K. A.; Vasil'ev, S. S.; Shavtvalov, L. Ya. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 104-7(Jan. 1969). (In Russian).

The ^{162}Ho nucleus and its daughter ^{62}Dy are deformed nuclei. The decay of ground and isomeric states of ^{162}Ho has not yet been sufficiently examined. Such a study was carried out on the basis of material prepared by the irradiation of ^{162}Dy by 6.5-MeV protons. The decay curve revealed two half-lives: 67 ± 2 min and 12 ± 2 min. The energy boundary value was found to be 1200 ± 50 keV. Because of the lower proton energy and shorter exposure time, the amount of the 67-min half-life isomer was low. The γ spectrum was studied by means of a scintillation γ spectrometer; it was found that the 55, 80, 185, 283, 930, and 1220 keV γ lines belong to ^{162}Ho ($T_{1/2} = 67$ min). Using specimens irradiated for shorter periods, therefore containing less of the 67-min isomer the 1330-keV gamma line of ^{162}Ho ($T_{1/2} = 11$ min) could be clearly identified. From comparison of the experimental and theoretical curves the parameter σ, which characterizes the distribution widths of nuclear levels according to the moment, was found to be 5.3 ± 0.9. (TTT)

42919 STUDY OF THE SPECTRA OF CONVERSION ELECTRONS OF ^{174*}Lu AND ^{174}Lu. Kartashov, V. M.; Novgorodov, A. F.; Troitskaya, A. G.; Shevelev, G. A. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 43-7(Jan. 1969). (In Russian).

A double-focusing spectrometer was used for investigating the half-life of the metastable state of ^{174}Lu and to examine the conversion electron spectra. The complex conversion lines of the transition were analyzed graphically. The observed decrease of the intensity of the conversion electron of the transition in ^{174}Lu and between the 4 lowest levels of ^{174}Yb did not contradict the decay scheme of ^{174m}Lu and ^{174}Lu proposed by L. Funke et al.; the half-life of the 170.89-keV metastable state of ^{174}Lu was found to be 80 ± 5 days. Differences with respect to earlier data reported in the literature are probably due to the fact that the half-life of ^{174m}Lu was determined earlier by comparing the drop in the intensity of the conversion lines of the transitions in ^{174}Lu and of the K 100.7-keV line of ^{173}Lu. It was found that the intensity of the K 100.7 line undergoes complex changes with time. (TTT)

42920 X RADIATION OF FRAGMENTS RESULTING FROM THE FISSION OF NUCLEI UNDER EMISSION OF LONG-PATH α PARTICLES. Solov'ev, S. M.; Eismont, S. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 159-62(Jan. 1969). (In Russian).

There is considerable interest in nuclear spectroscopic measurements to determine directly the instantaneous charge of fragments resulting from α-fission, i.e., the fission process involving the emission of long-range α particles. In this connection the spectra distribution and the intensity of radiation resulting from internal conversion and its dependence on the spin of the fission fragments were examined for the case of the thermal-neutron-induced fission of ^{235}U. The study included measurement of the yield and energy spectra of the K radiation in double and α fission, recording the X irradiation quanta under conditions of double (fragment-quantum) and triple (fragment-α particle-quantum) coincidences. The instrumentation included a xenon-filled proportional counter, a spectrometric amplifier, and a multichannel analyzer. The role of each fragment in the formation of α particles and its proton component may be resolved by measuring the K radiation of the fragments of α fission at a given splitting of the masses, as determined from the energy of the fragments. (TTT)

42921 THE γ RADIATION OF ^{111}Sn. Shilin, V. A.; Burmistrov, V. R.; Levkovskii, V. N. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 38-42(Jan. 1969). (In Russian).

A Ge(Li) spectrometer, calibrated with ^{22}Na, ^{56}Co, ^{60}Co, ^{124}Sb, ^{137}Cs, and ^{144}Ce + ^{144}Pr sources, was used for studying the γ radiation of ^{111}Sn, using an enriched target for the preparation of the source. The γ lines were identified by the half-life and their chemical properties. The ^{111}Sn was prepared by the ^{112}Sn(n,2n)^{111}Sn reaction with 66.2% enriched metallic tin and 14-MeV neutrons and the ^{110}Cd(α,3n)^{111}Sn reaction on 91.5%-enriched metallic Cd with 40-MeV α particles. The radiochemical separation revealed that irradiation of the Cd target also yields various indium isotopes. The mean half-life of ^{111}Sn calculated from the most intensive γ lines was found to be 35.8 ± 0.8 min.; this agrees with earlier findings. The half-life of the isomeric state of ^{111}In was found to be 7.6 ± 0.2 min. The results confirmed previous data on γ transitions which accompany the decay of ^{111}Sn. Additional new transitions were also observed at 457.5, 536.5, 564.6, 1025.0, 1099.5, 2212, and 2290 keV. The level scheme of ^{111}In and the γ transitions which accompany the decay of ^{111}Sn are presented graphically. It was assumed that a metastable state ^{111}Sn ($\frac{1}{2}^+$) was present; the half-life of this state is estimated to be not more than 1 hour. (TTT)

42922 THE DECAY OF ^{100}Rh. Anton'eva, N. M.; Grigor'ev, E. P.; Katykhin, G. S.; Protasova, L. F.; Vrzal, Ya.; Urbanets, Ya. (Leningrad State Univ. Joint Inst. for Nuclear Studies, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 27-37 (Jan. 1969). (In Russian).

The studies were carried out with a ^{100}Rh source obtained by the irradiation of a CdO source by 660-MeV protons in a synchrocyclotron and the separation of the rhodium chromatographically in the form of a rhodium–tin complex. Two coaxial Ge(Li) detectors and a 2048- and a 4096-channel analyzer were used for the measurements. The rate of drop of the intensity of the γ lines served to determine whether the quanta belonged to the ^{100}Rh isotope. The excited levels and transitions are examined. Among the listed ^{100}Ru levels some have not yet been observed because of their low intensity or their closeness to other lines. The intensities of these transitions were estimated. On the basis of 3% of β decays at the ground level of ^{100}Ru, it was calculated that for ^{100}Rh the intensity of the β decay branch at the ground state amounts to 2.3% and that of electron capture 0.4%. These data were used to calculate the γ transition intensities per 100 decays of ^{100}Rh, and of the portion of β decay and electron capture at each state. It was assumed that the ground state of $^{10}_{45}$Rh is $\frac{1}{2}^-$. (TTT)

42923 SHADOW EFFECT IN FISSION OF URANIUM. Melikov, Yu. V.; Otstavnov, Yu. D.; Tulinov, A. F. (Inst. of Nuclear Physics, Moscow). Zh. Eksp. Theor. Fiz., 56: 1803-5(June 1969). (In Russian).

Shadows in the directions of the crystallographic axes and planes were observed in the angular distribution of ^{238}U fission fragments produced by irradiating a UO$_2$ single crystal with 25-MeV α particles. The shadow patterns related to the whole set of crystal axes and planes (so-called fragmentograms) are obtained. The possibility of using this phenomenon to study the time characteristics of fission is discussed. The upper limit of the fission time is ~10^{-17} sec. (auth)

42924 MEASUREMENT OF THE STATIC AND TRANSITION ELECTRIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATE IN ^{114}Cd, ^{194}Pt, ^{196}Pt, AND ^{198}Pt, BY MEANS OF COULOMB EXCITATION. Glenn, John Edward. Pittsburgh, Univ. of Pittsburgh, 1968. 67p.

Thesis.

The ratio of inelastically scattered ^{16}O ions exciting the first 2^+ state to elastically scattered ions was measured as a function of scattering angle for the even-even isotopes ^{114}Cd, ^{194}Pt, ^{196}Pt, and ^{198}Pt using a 42-MeV ^{16}O beam. From precise measurements of this kind it is possible to deduce the reduced transition probabilities B(E2, $O^+ \rightarrow 2^+$) and the static quadrupole moments Q_{2+} of the first 2^+ states for these nuclei. The scattered ions were energy analyzed by means of an Enge split-pole spectrograph and detected by position sensitive detectors. Evaluation of the ^{114}Cd data gives values for the B(E2, $O^+ \rightarrow 2^+$) and Q_{2+} of 0.562 ± 0.008 $e^2 \cdot barn^2$ and 0.58 ± 0.22 e · barn, respectively. This is in good agreement with previous results obtained in Coulomb excitation experiments in which the geometry was held fixed and the projectile mass was varied. Evaluation of the platinum data gives values for the B(E2, $O^+ \rightarrow 2^+$) for ^{194}Pt, ^{196}Pt, and ^{198}Pt of 1.65 ± 0.02, 1.50 ± 0.03, and 1.01 ± 0.03, in units of $e^2 \cdot barn^2$ respectively. The values of the static quadrupole moment of the first 2^+ state Q_{2+} for ^{194}Pt, ^{196}Pt, and ^{198}Pt are found to be 0.72 ± 0.28, 0.54 ± 0.23, and 1.22 ± 0.50, in units of e · barn respectively. The platinum results are in qualitative agreement with the results of the theoretical calculations of Kumar and Baranger in this region. (Diss. Abstr.)

42925 ENERGY DEPENDENCE OF $\bar{\nu}_p$ FOR NEUTRON-INDUCED FISSION OF ^{235}U, ^{238}U, AND ^{239}Pu FROM 1.3 TO 15 MeV. Soleilhac, M.; Frehaut, J.; Gauriau, J. (CEA, Paris). J. Nucl. Energy, 23: 257-82(May 1969).

The energy dependence of $\bar{\nu}_p$, the average number of prompt neutrons per fission, was measured simultaneously for ^{235}U, ^{238}U, and ^{239}Pu over the incident energy range 1.5 to 15 MeV by comparing the number of prompt neutrons from neutron induced fission with that from spontaneous fission of ^{252}Cf. A time-of-flight selection system was used for all $\bar{\nu}_p$ determinations. For ^{238}U and ^{239}Pu the variation of $\bar{\nu}_p$ with energy is linear for 1.5 to 15 MeV. For ^{235}U at 6 MeV there is a rounded-off step due to the onset of the (n,n′f) process. (auth) (UK)

42926 THE HALF LIVES OF TWO EXCITED STATES IN ^{239}Np. Hutchinson, J. M. R.; Mann, W. B.; Smith, C. N.; Whittaker, J. K. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop., 20: 493-8(July 1969).

The half-life of the 74-keV($\frac{5}{2}^-$) state of ^{239}Np was determined to be 1.380 ± 0.032 nsec, where the uncertainty represents the sum of estimated bounds to the systematic error, ±0.010 nsec, and twice the standard error, ±0.022 nsec. The half-life of the 118-keV($\frac{7}{2}^-$) state of ^{239}Np was found to be less than 0.04 nsec. (auth) (UK)

42927 CROSS SECTIONS OF (n,p), (n,pn), AND (n,α) REACTIONS ON ^{238}U WITH 15-MeV NEUTRONS AND DETECTION OF ^{235}Th. Trautmann, N.; Denig, R.; Hermann, G. (Univ., Mainz). Radiochim. Acta, 11: 168-71(June 1969). (In German).

The following cross sections at 14.8-MeV neutron energy were measured, using chemical separations, by comparing the disintegration rates of the produced protactinium isotopes 2.3 min ^{238}Pa, 9.1 min ^{237}Pa and 24 min ^{235}Pa with the disintegration rate of the fission product ^{140}Ba formed with a known cross section in the same sample: ^{238}U(n,p)^{238}Pa 1.5 ± 0.4 mbarn, ^{238}U(n,pn)^{237}Pa 0.23 ± 0.05 mbarn and—via the daughter product ^{235}Pa—^{238}U(n,α)^{235}Th 0.60 ± 0.15 mbarn. A cross section of about 6 mbarn was estimated for the ^{235}U(n,p)^{235}Pa reaction. A new isotope of thorium, ^{235}Th with a half-life of 6.9 ± 0.2 min, was found by repeated milking of ^{235}Pa. (auth)

42928 DETERMINATION OF THE DECAY RATIO β^-/EC OF ^{242}Am. Gasteiger, R.; Hoehlein, G.; Weinlaender, W. (Technische Hochschule, Munich). Radiochim. Acta, 11: 158-61(June 1969). (In German).

The disintegration ratio β^-/EC of ^{212}Am was redetermined giving a value of 4.8 ± 0.1. The determination is based on the α-spectroscopy of the two Pu isotopes 238 and 242. The method allows to avoid systematic errors as caused by long term irradiations and inaccurate neutron fluxes. (auth)

42929 EVIDENCE AGAINST THE 1580-keV LEVEL IN ^{134}Ba PROPOSED BY T. S. Nagpal. Singh, B.; Kukoc, A. H.; Taylor, H. W. (Univ. of Toronto). Can. J. Phys., 47: 1863-4(Sept. 1, 1969).

The gamma-ray spectrum of ^{134}Cs was studied with a high-resolution Ge(Li) detector in order to obtain evidence of a 1580-keV transition reported elsewhere. No evidence for a 1580-keV level was observed in the spectrum. (auth)(Canada)

42930 NEUTRON EMISSION FROM NUCLEAR EXCITATION BY RADIATIONLESS TRANSITIONS IN μ-ATOMIC ^{209}Bi. Hargrove, C. K. (National Research Council of Canada, Ottawa); Hincks, E. P.; Mason, G. R.; McKee, R. J.; Kessler, D.; Ricci, S. Phys. Rev. Lett., 23: 215-18(Aug. 4, 1969).

Neutron emission by radiationless μ-atomic transitions in ^{209}Bi was observed. The analysis of the neutron time-of-flight spectrum shows that this process takes place in muon transitions from the n = 3 or higher states to the ground state of the muonic atom while the nucleus is left either in the ground state or in an excited state, possibly one belonging to a particle-hole multiplet of ^{208}Bi. The process investigated here occurs in 7 ± 2% of all muon stops in bismuth. (auth)

42931 MEASUREMENT OF THE g-FACTORS FOR THE ^{181}Ta 482-keV AND ^{99}Tc 181-keV LEVELS. Begzhanov, R. B.; Gaffarov, D.; Salikhaev, K. T. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 12, 14-16(1968). (In Russian).

A fast–slow coincidence system was used to measure the g-factors for the 482-keV level of ^{181}Ta and the 181-keV level of ^{99}Tc. (R.V.J.)

42932 ANALYSIS OF Nd NEUTRON RESONANCES. Migneco, E.; Theobald, J.; Weighmann, H. (EURATOM, Geel, Belgium). J. Nucl. Energy, 23: 369-71(July 1969).

Capture and scattering cross-section measurements were made on natural Nd by use of the CBNM linear accelerator as a pulsed-neutron source. The data were analyzed by resonance methods. (UK)

42933 THEORETICAL ENERGY LEVELS OF LEAD ISOTOPES. Kriechbaum, M.; Urban, P. (Univ., Graz). Acta Phys. Austr., 28: 109-20(1968). (In German).

The levels of ^{200}Pb to ^{207}Pb and ^{210}Pb were calculated with pairing forces and P_2- and P_3-forces. The particle number fluctuation was considered through the expression $H' = H - \lambda_1 N - \lambda_2 N^2$. The interaction intensities are expressed. (tr-auth)

42934 KINETIC ENERGY SPECTRA OF FOIL-TRANSMITTED FISSION FRAGMENTS OF ^{252}Cf. Bridwell, L.; Bucy, Shawn (Murray State Univ., Ky.). Nucl. Sci. Eng., 37: 224-7 (Aug. 1969).

A mathematical model for the calculation of kinetic-energy spectra of fragments from the spontaneous fission of ^{252}Cf has been developed. This model predicts the spectra of these fragments after transmission through any absorber whose thickness and composition are known. The model may be applied to other fissioning elements with minor modifications. Agreement between calculated and experimentally observed peak positions agree to within 5%. The energy shifts due to an absorber may be calculated to within 25% for the thicknesses of foils used. (auth)

42935 THERMAL-NEUTRON CAPTURE CROSS SECTION AND RESONANCE INTEGRAL OF ^{252}Cf. Halperin, J.; Bemis, C. E.; Druschel, R. E.; Stokely, J. R. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 37: 228-31(Aug. 1969).

The capture thermal cross section and resonance integral of ^{252}Cf were measured in reactor irradiations using activation techniques. Values of $\sigma_{2200} = 20.4 \pm 2$ and $I = 43.5 \pm 3$ barns are reported. (auth)

42936 TRANSMISSION MEASUREMENT OF THE ^{252}Cf FISSION NEUTRON SPECTRUM. Green, L. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 37: 232-42 (Aug. 1969).

The spontaneous fission neutron spectrum from ^{252}Cf was measured using a variation of the transmission method. An excellent fit to the data was calculated assuming a Maxwellian spectrum shape with a temperature of 1.39 ± 0.04 MeV. The error includes contributions from uncertainties in cross sections and experimental statistics. In addition, all other possible sources of systematic error were investigated and found to be negligible. This value is in good agreement with earlier results at the low end of the range of measured values of the Maxwellian temperature. (auth)

42937 SPIN DETERMINATION FOR RESONANCES DECAYING TO EXCITED J = 0 STATES. Hausman, T.; Lieb, K. P. (Univ. of Texas, Austin). Phys. Rev. Lett., 23: 137-9(July 21, 1969).

The angular distribution of a (p,p′) resonance reaction leading to an excited $J_f = 0$ target state allows an unambiguous determination of the spin of the resonance. Isobaric analog resonances in ^{95}Nb decaying to the 1.30-MeV 0^+ state in ^{94}Zr were investigated. The weak-coupling nature of the parent states in ^{95}Zr is discussed. (auth)

42938 FISSION ISOMERISM INDUCED BY HELIUM IONS. Metag, V.; Repnow, R.; von Brentano, P.; Fox, J. D. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 226: 1-6(1969).

Delayed fission events due to isomeric fission have been produced using ^{3}He and ^{4}He beams. The isomeric nuclei which recoil from the target and subsequently fission in flight were detected by a square cone array of polycarbonate foil detectors mounted along the beam direction. From the distribution of fission tracks along the detector foils, half-lives in the nanosecond region were deduced. (auth)

42939 BETA CONTINUUM MEASUREMENTS ON ^{226}Ac AND DAUGHTER PRODUCTS OF ^{225}Ac. Van Krugten, H.; Koopmann, E. W. (Technische Hogeschool, Delft, Netherlands). Physica, 40: 253-6(Dec. 13, 1968).

Recent interest in the decay chains of the heavy elements revealed the necessity of accurate measurements in the beta-continuum endpoints of the isotopes of the actinium series. Measurements were performed with a sector-focusing spectrometer with a $B = B_0/r$ field, which appeared to be very suitable to this type of investigation, due to its very low scattering. Endpoint energies of ^{226}Ac were found to be (1105 ± 10) keV and (885 ± 7) keV. In the decay of ^{225}Ac three endpoints were measured, vis: (1420 ± 10) keV, (1018 ± 15) keV, and (634 ± 10) keV. (auth)

42940 THE SPIN OF THE 1029 keV LEVEL IN ^{200}Hg. Loebner, K. E. G.; Rabenstein, D.; Schult, O. W. B. (Technische Hochschule, Munich). Z. Phys., 226: 13-16(1969).

The spin of the 1,029 keV level in ^{200}Hg was determined to be 0 through measurements of the γ–γ-angular correlation of the 661 keV and 368 keV γ rays following slow neutron capture in ^{199}Hg. The upper limit for the γ-intensity ratio $I\gamma$(1,029 keV)/$I\gamma$(661 keV) obtained from the curved crystal spectrometer (n,γ)-data is much lower than the ratio found during the $^{200}\text{Tl} \rightarrow {}^{200}\text{Hg}$ decay studies. This implies that the 1,029 keV γ-line seen in the decay work does not lead from the 1,029 keV level to the ground state in ^{200}Hg, but that it depopulates a level which is only weakly fed through the (n,γ) process. (auth)

42941 DECAY OF ^{154}Tb ISOMERS WITH HALF LIVES OF 8 AND 24 HOURS. Badescu-Singureanu, Al. I.; Dorcioman, D.; Enulescu, Al.; Grecescu, M.; Ionescu, V. A.; Piticu, I.; Nascutiu, T. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 113-17(1969). (In French).

The γ singles and coincidence spectra for the 8 and 21 hour activities of ^{154}Tb were measured with NaI(Tl) spectrometers. The singles spectra were also measured with a Ge(Li) detector. A very weak positron activity with $T_{½} \geq 77$ days was also observed. A decay scheme for ^{154}Tb is proposed. (J.W.R.)

42942 DETERMINATION OF RESONANCE PARAMETERS FOR ^{133}Cs. Jung, H. H.; Priesmeyer, H. G. (Univ., Kiel). Atomkernenergie, 14: 271-2(July-Aug. 1969).

Resonance parameters for ^{133}Cs were determined from total neutron cross section measurements in the energy range from 0 to 400 eV by area analysis. Resolutions were from 163 to 31 ns/m. From these parameters an average level spacing per spin state of D = 44,4 eV and a strength function of $S = 1{,}1 \cdot 10^{-4}$ were calculated. (auth)

42943 FISSION-FRAGMENT ANGULAR CORRELATIONS FOR ^{233}U, ^{235}U, AND ^{239}Pu(t,df) REACTIONS. Britt, H. C.; Cramer, J. D. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 181: 1634-9(May 20, 1969).

Measurements have been made of the angular correlations of fission fragments emitted from the (t,df) reaction on ^{233}U, ^{235}U, and ^{239}Pu targets with an 18-MeV incident triton beam for deuterons observed at 130°. The results have been fitted to the function $W(\theta) = A_0[1 + \Sigma_{L} g_L P_L(\cos\theta)]$, and coefficients A_0, g_2, g_4, and g_6 were determined as a function of excitation energy. Fission probabilities were determined from the A_0 coefficient. The results are generally very similar to previous (d,pf) results. (auth)

42944 ^{208}Pb(n,γ) CROSS SECTIONS BY ACTIVATION BETWEEN 10 AND 200 keV. Macklin, R. L.; Gibbons, J. H. (Oak Ridge National Lab., Tenn.). Phys. Rev., 181: 1639-42(May 20, 1969).

The ^{208}Pb(n,γ)^{209}Pb activation cross section has been measured in the energy range relevant to stellar nucleosynthesis. A large-area, low-background β-ray counting system was developed to obtain sufficient sensitivity. Information on the radiative widths of the known resonances below 120 keV was derived. The cross-section average found for the Maxwellian temperature distribution assumed for a stellar interior (kT = 30 keV) is $\frac{1}{3}$ mb. This value is quite compatible with expectations based on current nucleosynthesis theory. (auth)

42945 HIGH-SPIN THREE-PARTICLE STATES IN ^{207}Bi. Bergstroem, I. (Research Inst. for Physics, Stockholm); Herrlander, C. J.; Thieberger, P.; Blomqvist, J. Phys. Rev., 181: 1642-9(May 20, 1969).

High-spin three-particle levels populated in the decay of a 182 ± 6-μsec isomeric state in ^{207}Bi have been studied using the pulsed external beam of the Stockholm 225-cm cyclotron. The isomeric state was produced in the ^{205}Tl(28-MeV α,2n)^{207}Bi reaction. The intensities and energies of the 13 delayed γ transitions observed fit consistently into a level scheme of six excited levels having energies (keV) and spins: 2101.5 ($\frac{21}{2}$), 1645.4 ($\frac{15}{2}$), 1357.9 ($\frac{15}{2}$), 1240.5 ($\frac{13}{2}$), 931.8 ($\frac{13}{2}$), and 669.5 ($\frac{11}{2}^-$). Shell-model calculations have been performed showing that the observed levels can be interpreted as resulting from the coupling of the two-neutron-hole states in ^{206}Pb with the odd proton. From the known level structure of ^{206}Pb and the investigation of the n-p interaction in ^{208}Bi, the theoretically expected level structure of ^{207}Bi has been calculated. The average energy difference between theoretically and experimentally determined levels is as low as 18 keV, and the agreement of experimental and theoretical transition probabilities is also satisfactory. The spin assignments are confirmed, and all levels except the $\frac{21}{2}$ are found to have odd parity. (auth)

42946 GAMMA RAYS AND TRANSITION MULTIPOLARITIES IN THE DECAY OF 15.8-h ^{186}Ir. Sugihara, T. T. (Brookhaven National Lab., Upton, N. Y. Clark Univ., Worcester, Mass. Texas A and M Univ., College Station); Keenan, J. A.; Perlman, M. L. Phys. Rev., 181: 1650-64(May 20, 1969).

Energies and intensities of 127 γ rays emitted in the decay of 15.8-h ^{186}Ir have been determined with high-resolution Ge(Li) detectors. When combined with conversion-electron intensities of previous workers, γ-ray intensities led to conversion coefficients and assignment of multipole orders to most transitions. Differences among existing level schemes of ^{186}Os were largely resolved. Previously established ground-state and K = 2 γ-vibrational bands were strongly supported. A tentative suggestion of a K = 4 band, which had been proposed earlier, was also supported. A number of new levels have been proposed to accommodate the observed high-energy transitions, some of which have E0 components. (auth)

42947 NUCLEAR SPIN AND HYPERFINE STRUCTURE OF ^{121}Sn AND ^{113}Sn. Prior, Michael H.; Dymanus, Antoni; Shugart, Howard A.; Vanden Bout, Paul A. (Univ. of California, Berkeley). Phys. Rev., 181: 1665-74(May 20, 1969).

The atomic-beam magnetic-resonance technique was used to measure the nuclear spin I and hyperfine structure interaction constants a and b of 27-h ^{121}Sn and 118-day ^{113}Sn in the $^3P_1$ electronic state. From the measured interaction constants values for the nuclear magnetic-dipole and electric quadrupole moments μ_I and Q are deduced. The results are, for ^{121}Sn: I = $\frac{3}{2}$, a = ±128.726(8) MHz, b = ±32.374(12) MHz, b/a > 0, from which μ_I (uncorr) = ∓0.695(7) μ_N and Q = ±0.08(4) b; and for ^{113}Sn: I = $\frac{1}{2}$, a = ±485.911(25) MHz, from which μ_I(uncorr) = ∓0.875(9) μ_N. (auth)

42948 ^{243}Am α DECAY: MULTIPOLARITY OF γ TRANSITIONS. Engelkemeir, D. (Argonne National Lab., Ill.). Phys. Rev., 181: 1675-81(May 20, 1969).

Conversion coefficients and probable multipolarities were measured for seven γ rays from levels of ^{239}Np populated by the α decay of ^{243}Am. The γ energies in keV and their multipolarities are 43.1 keV (M1 + E2), 55.4 keV (M1 + E2), 74.7 keV (E1), 86.7 keV (E1), 98.5 keV (E2), 117.8 keV (E1), and 142.0 keV (E1). The multipolarities of the 74.7- and 117.8-keV γ's have been previously reported. The 98.5-keV transition was seen only in e$^-$ spectra and has not been noted before. These multipolarities are in agreement with level spin assignments. Gamma branching ratios from the 74.7-, 117.8-, and 173.2-keV levels have been calculated. Coincidences with α's were required in order to eliminate radiations from the β$^-$ decay of the ^{239}Np daughter. The 100-mm^2 × 3-mm-deep Si(Li) detector gave an e$^-$ resolution of 2.0 keV over the energy range studied. Both the detector and the field-effect transistor input stage were cooled to −150°C. (auth)

42949 ^{135}Ba(n,γ) REACTION AND LEVEL STRUCTURE OF ^{136}Ba. Gelletly, W.; Moragues, J. A.; Mariscotti, M. A. J.; Kane, W. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 181: 1682-96(May 20, 1969).

The γ rays from the ^{135}Ba(n$_{th}$,γ)^{136}Ba reaction have been studied in singles and in coincidence with a 9-cm^3 Ge(Li) detector and a Ge(Li)-NaI detector combination. Of the 78 γ rays assigned to ^{136}Ba, 16 have been identified as primary transitions deexciting the compound nucleus. These primary γ rays have energies (in keV) and relative intensities [I(818 keV) = 100] as follows: 9106.5 ± 1.3 (2.9), 8288.2 ± 0.8 (1.8), 7554.3 ± 1.0 (0.24), 7526.6 ± 2.0 (0.07), 7026.4 ± 0.7 (0.7), 6978.2 ± 0.7 (0.2), 6707.4 ± 0.8 (0.3), 6574.9 ± 0.6 (0.5), 6087.4 ± 0.5 (0.3), 6063.5 ± 0.4 (3.5), 5673.2 ± 0.6 (0.4), 5601.8 ± 0.6 (1.0), 5415.8 ± 0.5 (2.2), 5340.3 ± 0.7 (0.2), 5311.9 ± 0.6 (3.7), and 5181.5 ± 2.6 (0.9). These data, together with the information obtained from the coincidence studies and from previous decay scheme and neutron capture γ-ray studies, establish levels in ^{136}Ba with energies 818.6 ± 0.2, 1550.5 ± 0.4, 1579.2 ± 0.4, 1866.3 ± 0.4, 2030.0 ± 0.5, 2053.5 ± 0.6, 2079.9 ± 0.6, 2128.3 ± 0.8, 2139.6 ± 0.6, 2206.3 ± 0.5, 2398.6 ± 0.3, 2531.8 ± 0.5, 3019.9 ± 0.5, 3043.6 ± 1.4, 3433.2 ± 0.5, 3504.9 ± 1.1, 3690.8 ± 1.5, 3767.1 ± 1.0, 3795.4 ± 0.9, and 3925.7 ± 1.2 keV. The neutron separation energy was found to be 9106.4 ± 0.8 keV. The level scheme of ^{136}Ba is discussed. The branching ratio B(E2; 2 +′ → 0 +)/B(E2; 2 +′ → 2 +) was measured and found to be 0.029 ± 0.006, in agreement with measured values of the same quantity for other near-harmonic nuclei. (auth)

42950 THEORETICAL ALPHA-DECAY RATES FOR THE ACTINIDE REGION. Poggenburg, J. K. (Oak Ridge National Lab., Tenn.); Mang, H. J.; Rasmussen, J. O. Phys. Rev., 181: 1697-1719(May 20, 1969).

The theoretical development of the microscopic (shell-model) theory of α decay of deformed nuclei is reviewed, and the detailed formulas applying to even- and odd-mass nuclei are presented. Results are presented from new calculations on ground-rotational-band α-decay patterns for even-even nuclei from atomic numbers 90−106. These calculations represent a refinement over previously published work in that particle-number-conserving variational wave functions were used instead of Bardeen-Cooper-Schrieffer (BCS) wave functions. The new results for even nuclei are not, however, very different from the earlier BCS results. The main contribution of this paper is the tabulation of several hundred theoretical α amplitudes for odd-mass nuclei from elements 92−101. The theoretical intensities derived from these tables are compared with experiment for a representative sampling of α emitters. The main factors governing hindrance for unfavored transitions are discussed in terms of loss of the pairing correlation enhancement and in terms of the Nilsson functions of the odd-nucleon wave function. (auth)

42951 THE ALPHA DECAYS OF ^{210}Bi AND ^{210m}Bi TO LEVELS IN ^{206}Tl. Lange, Robert C.; Hagee, G. Richard; Campbell, Allen R. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT-33-1-GEN-53. Nucl. Phys., A133: 273-88(1969).

The radiations accompanying the α decay of ^{210m}Bi and ^{210}Bi to ^{206}Tl were studied. The decay of ^{210m}Bi involves six α groups with the following energies and intensities: α_0 = 5.201 MeV (0.04%), α_{266} = 4.935 MeV (54.6%), α_{305} = 4.896 MeV (40.4%), α_{634} = 4.568 MeV (0.96%), α_{650} = 4.550 MeV (3.74%), and α_{802} = 4.400 MeV (0.19%). The γ rays in ^{206}Tl, following α-decay of ^{210m}Bi, have the following energies and relative intensities: 266 keV (100), 305 keV (54), 329 keV (1.1), 344 keV (1.4), 368 keV (1.3), 534 keV (0.5), 634 keV (0.02), and 650 keV (5.6). Coincidence experiments provided direct evidence for confirmation of the level scheme for ^{206}Tl, and for closure of the decay chain around the A = 210, 206 α, β cycle. (auth)

42952 K-SHELL PARTICLE PARAMETER OF THE 123 keV TRANSITION IN ^{154}Gd. Koopmann, E. W.; Van Krugten, H. (Technische Hogeschool, Delft, Netherlands). Physica, 42: 262-4(Apr. 21, 1969).

The effect of different physical conditions of the source on the attenuation of the angular correlation measurements is considered. It turns out that the K-shell particle parameter of the 123-keV E2 transition in ^{154}Gd is in good agreement with the theoretical prediction if the γ−e$^-$ and the γ−γ angular correlation measurements are performed under the same physical conditions. (auth)

42953 PHOTONEUTRON CROSS SECTIONS OF I, Ce, Sm, Er, AND Lu. Bergere, R.; Beil, H.; Carlos, P.; Veyssiere, A. (CEN, Saclay, France). Nucl. Phys., A133: 417-37(1969). (In French).

Partial and total photoneutron cross sections for natural I, Ce, Sm, Er, and Lu were measured as a function of photon energy up to 30 MeV using a monoenergetic photon beam created by the annihilation in flight of monochromatic positrons. Measured threshold values for $\sigma(\gamma,2N)$, and $\sigma(\gamma,3n)$ are in good agreement with theoretical values. From a two Lorentz curve fit to the measured total photonuclear cross sections intrinsic quadrupole moments Q_0, and deformation parameters β_2 were obtained. Experimental values for the integrated cross sections σ_0, σ_{-1}, and σ_{-2} are calculated and compared with several theoretical expressions. Finally, a set of nuclear density parameters and the corresponding nuclear temperatures are also determined. (auth)

42954 STUDIES IN THE DECAY OF ^{103}Pd. Grunditz, Y.; Antman, S.; Pettersson, H.; Saraceno, M. (Univ. of Uppsala). Nucl. Phys., A133: 369-84(1969).

The decay of ^{103}Pd was studied using a double-focusing beta spectrometer and a Ge(Li) detector. The K-Auger-electron, conversion-electron, K x-ray, and gamma-ray intensities were determined. Precision energy determinations were obtained from the gamma-ray measurements with the Ge(Li) detector. The multipolarity mixture in the 40 keV transition was determined in a high-resolution L-subshell measurement. Conversion coefficients were calculated and log ft values deduced from normalized transition intensities. A level scheme for ^{103}Rh with spins and parities is proposed from the data, and a comparative discussion is included using existing data obtained from studies in the decay of ^{103}Ru. (auth)

Nuclear Theory

Refer also to abstracts 41785, 41786, 41946, 42592, 42616, 42634, 42636, 42690, 42848, and 42916.

42955 (BNL-tr-273) EFFECT OF THE OPTICAL-MODEL PARAMETERS ON CHANNEL ANALYSIS OF THE NEUTRON-INDUCED NUCLEAR FISSION. Ermagambetov, S. B.; Kolesov, V. E.; Nesterov, V. G.; Smirenkin, G. N.; Tishin, A. S. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz., 8: 704-12(1968). 22p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 9048.

42956 (CEA-Bib-146) STUDIES ON FISSION PRODUCTS. Breton, Denis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 19p. (In French). Dep.

After a review of the theories predicting the nature (characterized by the numbers A and Z) of the products formed immediately after fission the hypotheses are given, and a model established by BENZI is developed for calculating the capture cross-sections $\sigma(n,\gamma)$. The determination of the parameters required for evaluating cross-sections is also considered. This is essentially a bibliographical study. (auth)

42957 (LNF-69/18) THE RHO-GAMMA COUPLING AND THE OPTICAL MODEL. Note No. 438. Wilson, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Apr. 4, 1969. 9p. Dep.

Recent attempts to measure the ρ meson nuclear coupling constant and the nucleon total cross section by photoproduction in complex nuclei led to different results. Several possible causes of the discrepancy are discussed. (auth)

42958 (NP-tr-1787) STRUCTURE OF COMPLEX NUCLEI. LECTURES PRESENTED AT AN INTERNATIONAL SUMMER SCHOOL FOR PHYSICSTS. Bogolyubov, N. N. (ed.). Translation of Struktura Slozhnykh Yader. Letnyaya Shkola Fizikov, Atomizdat, Moscow, 1966. 217p.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 1739.

42959 (ORNL-TM-2556) AN EFFECTIVE NUCLEON-NUCLEON INTERACTION FOR USE IN NUCLEAR HARTREE-FOCK CALCULATIONS. Nestor, C. W. Jr. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 152p. Dep. CFSTI.

Thesis. Submitted to Vanderbilt Univ., Nashville, Tenn.

Certain properties of a particular type of nonlocal potential, one which includes a quadratic velocity dependent repulsion, were explored. The primary emphasis was on the determination of the parameters defining the effective interaction so that the values of the energy and density of infinite nuclear matter, as calculated in the Hartree-Fock approximation, would match the experimental values of these quantities. The reason for this emphasis, rather than the more conventional one of fitting two-body scattering data, is the observation that two potentials of very different form and predicted two-body phase shifts gave almost identical shell-model wave functions and energy levels in selected finite nuclei when the parameters were adjusted to match the energy and density of nuclear matter. It is desirable to find an effective interaction which does as little violence as possible to the two-body data, and sometime was devoted to the two-body problem. However, for the potentials studied to date, the two-body phase shifts are not fitted very well, particularly at high energies. The requirement of fitting the energy and density of nuclear matter was satisfied, and some nuclear Hartree-Fock calculations with these potentials gave good agreement with experiment for light spherical nuclei, so the misfit to the high-energy phase shifts does not appear to be a serious disadvantage. The predicted properties of heavier spherical nuclei, calculated in the Hartree-Fock approximation with the potentials studied do not agree with experiment. Further work is needed to resolve this discrepancy, which appears to be due to different sources than does the misfit to the high-energy phase shifts. (auth)

42960 (ORNL-tr-2034) ACTIVITY OF THE FISSION PRODUCTS OF ^{235}U AND ^{239}Pu. de Tourreil, R. Translated for Oak Ridge National Lab., Tenn., from J. Nucl. Energy, 22: 231-49 (Apr. 1968). 24p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 29991.

42961 (ORNL-tr-2041) PROGRAM FOR THE CALCULATION OF FISSION PRODUCT ACTIVITY. de Tourreil, Roland (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report Cea-Note-N-824. 17p. Dep. CFSTI.

The PEPIN LE BREF program furnishes the exact β and γ activities of completely known fission products. Using analytical expressions of the solutions of differential equations, it computes the desired β and γ activities. The PLUS PEPIN program introduces the β and γ activities of fission products whose properties are partially known. It calculates these activities on the basis of a computing approximation because in principle it is only provisional and later, it should be possible to integrate it in the PEPIN LE BREF program. The description of these two programs is presented in detail so as to facilitate their management. (auth)

42962 (OU-LNS-69-3) STROBOSCOPIC OBSERVATION OF LARMOR PRECESSION IN NUCLEAR EXCITED STATES. Nagamiya, Shoji; Sugimoto, Kenzo (Osaka Univ. (Japan). Lab. of Nuclear Studies). Apr. 30, 1969. 26p. Dep.

A new simple method of accurately determining the g-factor of nuclear excited levels is studied. The method is named the "stroboscopic method" because its principle is similar to that of the stroboscope. The formula for the expected line shape is derived. The influence on the line shape arising from (1) width of beam pulse, (2) spread of observation time, and (3) irregularity in beam repetition time is discussed. A computer program is presented by which one may calculate the expected line shape. (auth)

42963 (RT/FI-(69)7) A FORTRAN PROGRAMME FOR THE ADIABATIC COUPLED-CHANNEL CALCULATION OF NUCLEAR PARTICLE SCATTERING BY ROTATIONAL NUCLEI. Fabbri, F.; Zuffi, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 17p. Dep.

The Programme ADAPE can calculate, with the coupled-channel method, the total cross section and the total and differential elastic and inelastic scattering cross sections for spin 0 or ½ nuclear particles from a rotational (permanently deformed) nucleus of either even or odd A. The adiabatic approximation is assumed to be valid. (auth)

42964 (UJV-2067-F) RELATIVISTIC KINEMATICS IN NUCLEAR REACTIONS. Rikovska, J.; Kroha, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct. 1968. 50p. (In Czech). Dep.

Results of measurements of nuclear reactions and those involving elementary particles must be subjected to kinematic analysis. This requires a determination of the correlation between the angular distribution of the emitted particles and their energies and a comparison of the data with theoretical predictions. The relativistic kinematics of all fundamental reactions with two products in the output channel are summarized. Studies were also carried out on the determination of the optimum position of the target in order to minimize the energy scatter of the reaction products. The results were analyzed by means of a special computer program. Soviet papers on the kinematics of nuclear reactions are listed. (TTT)

42965 CONTRIBUTIONS TO THE THEORY OF THE DIFFRACTION SPLITTING OF DEUTERONS. Berezhnoi, Yu. A.; Evlanov, M. V. (Physical-Technical Inst., Kharkov). Izv.

Akad. Nauk SSSR, Ser. Fiz., 33: 167-73(Jan. 1969). (In Russian).

The dependence of the angular correlations on the direction of emission of nucleons released by the splitting of dueterons and the correlation between energy distribution of nucleons, the form of the potential of nuclear interactions between neutrons and protons of deuterons, the energy of emitting deuterons, and the dimensions of the target nucleus were investigated. Conditions were derived for the shape of the potential well of the interaction between the nucleons of the deuterons and for determining the differential elastic scattering cross section of the splitting of deuterons. Experimental data were obtained for a heavy (Au) and light (Ni) nucleus determining the effect of the increase of the emission angle of protons for the overall diffraction picture. (TTT)

42966 MECHANISM OF THE CASCADE RADIATION OF NEUTRONS FROM FISSION FRAGMENTS OF NUCLEI. Zommer, V. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 163-6(Jan. 1969). (In Russian).

Many experimental problems of nuclear reactions, such as the probability of spontaneously fissioning isomers, may be resolved by means of cascade statistics. In this connection, the hypothesis of the "isothermic" neutron radiation is described qualitatively considering a nucleus subjected to the high but not necessarily equilibrium deformation. It is assumed that the nucleus is cold, i.e., the excess energy to be removed by neutrons and γ quanta is included in the defomation energy. Under such conditions no heat radiation from the heavy nuclei is possible. The nucleus is heated up by changing its shape toward its ultimate equilibrium form; the time required for this is much longer than the time of flight by the nucleon by the distance for the order of the radius of the nucleus. The time to reach the temperature of evaporation also plays an important role. Study of these processes reveals that emission of each neutron in a cascade represents an event with its specific time within the process involved in reaching the ultimate equilibrium deformation of the original nucleus. The prompt neutron spectrum emitted by the fragments from the spontaneous fission of ^{252}Cf was examined to determine the isothermic character of the cascade emission of neutrons. The results indicated that if T. D. Newton's level density parameters are used, the neutron spectrum data from the spontaneous fission fragments of ^{252}Cf do not contradict the assumption of an isothermic evaporation of neutrons. (TTT)

42967 MULTIPARTICLE GENEOLOGIC COEFFICIENTS AND THE TRANSLATION-INVARIANT SHELL MODEL. Kurdyumov, I. V.; Smirnov, Yu. F.; El'Samarai, S. Kh.; Shitikova, K. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 150-8 (Jan. 1969). (In Russian).

The technique of genologic coefficients (GC) proposed by G. Racah is very convenient for developing antisymmetric shell wave functions for a system of n particles and for calculating the matrix elements of various operators. As the problem of the separation of multiparticle GC into orbital and spin-isospin genologic coefficients has not yet been investigated, the factorization of GC was examined, presenting some general formulas for calculating multiparticle orbital and spin-isospin GC. The formulas were transposed to make them suitable for examining the translational-invariant shell model. (TTT)

42968 A COMPUTER PROGRAMMING SYSTEM BASED ON THE HAUSER-FESHBACH THEORY. Antropov, A. E.; Zarubin, P. P.; Orlov, B. N.; Plavko, A. V.; Sorokin, A. I. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 114-15(Jan. 1969). (In Russian).

A computer program was derived for calculating the inelastic scattering cross section of protons on the basis of the equations presented in the Hauser–Feshbach theory. Keeping in mind the parity of the compound nucleus, the cross section is represented by the sum of "partial" scattering cross sections of the different levels of the compound nucleus with stated spins and parities. The least-squares method was used for obtaining nonnegative values of the parameters for which the theoretical cross section is closest to the experimental values corresponding to a certain basic level with a given spin and parity. The proton penetrability coefficients of the optical model potential of G. S. Mani et al., were used for the calculations. The method is sensitive toward a spin and parity of the final nucleus and may be used to determine them. (TTT)

42969 γ TRANSITIONS UNDER NONCONSERVATION OF PARITY. Voikhanskii, M. E.; Listengarten, M. A. (All-Union Scientific Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 98-103(Jan. 1969). (In Russian).

Study of the nonconservation of parity in γ transitions, as in the measurement of the circular polarization of the γ radiation upon the 396.3-keV transition in the ^{175}Lu nucleus, may serve to verify the theory of universal weak interactions. Use of all the components of the wave function instead of one of the largest ones changes the value of R, the ratio of matrix elements of regular and irregular transitions, by a factor of up to 3 with respect to F. Michel's data. Use of the Saxon–Woods potentials instead of Nilsson potentials affects only slightly the values of R and F, the parameter indicating the admixture of a state with opposite parity. The value of R for the 396-keV transformation in ^{175}Lu together with results of V. M. Lobashev et al., for circular polarization of γ radiation agrees with the F value characterizing weak nucleon–nucleon potentials under nonconservation of parity; it also agrees with the value given by F. Michel calculated under the assumption of conservation of the vector current. On the basis of this data it was found that the degree of circular polarization P_γ for the 283- and 145-keV transitions is 1.4×10^{-5} and 0.5×10^{-5}, respectively. (TTT)

42970 RASSEY WAVE FUNCTIONS AND γ TRANSITIONS IN DEFORMED NUCLEI. Voikhanskii, M. E.; Voronkov, Yu. P. (All-Union Scientific Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 92-7(Jan. 1969). (In Russian).

The Nilsson estimation of the lifetimes of the excited states of deformed nuclei requires the use of wave functions and formulas for the transition probability, involving eigenfunctions of the spherical harmonic oscillators; however, the use of quantum numbers which characterize the spherical nucleus requires large numbers of calculations. A. Rassey, Lyu Yuan, and Chu Lyan-Yu succeeded in presenting the internal wave functions by expanding them on the basis of eigenfunctions of the anisotropic harmonic oscillator. This was further developed to obtain formulas for calculating the probability of electric and magnetic one-particle transitions. The Nilsson approximation was used in the derivations. The selection rules to be followed for summing the equations according to asymptotic quantum numbers are indicated. Use of the formulas derived greatly simplify the computations. (TTT)

42971 AMPLITUDE OF THE NONRELATIVISTIC SQUARE DIAGRAM. Blokhintsev, L. D.; Truglik, E. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 88-91(Jan. 1969). (In Russian).

In the diagram theory of low- and intermediate-energy direct nuclear reactions, the amplitude of the direct reactions is given in the form of a nonrelativistic Feynman diagram with corresponding apical functions. A given diagram is selected on the basis of the distance of the characteristic of its amplitude from the physical region of the investigated reaction. This requires the study of the simplest nonrelativistic diagrams with few virtual lines. The analytical properties of nonrelativistic square diagrams with constant peaks were examined. A connection was established between the amplitudes of square diagrams and matrix elements for $A + x \rightarrow B + y$ type processes, given in the conventional formalism of interaction wave functions and potentials. The four types of square diagrams resulting from the different reaction mechanisms were analyzed. The energy integration in the Feynman integral leads to the appearance of two components corresponding to the two poles of the integrand in the energy plane. The amplitudes were found to be similar to the first and second Born approximations. (TTT)

42972 FUNCTIONS FOR ANALYZING THE ELECTRON CAPTURE FROM THE K AND L SHELLS OF THE ATOM. Suslov, Yu. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 78-83 (Jan. 1969). (In Russian).

Following up previously published functions for analyzing electron capture from the K and L shells, new functions were derived for the $Z = 2$ to 98 range to determine the probability of permissible and forbidden K and L captures. The nonrelativistic self-consistent potential was used for the calculation up to $Z = 71$, whereby the exchange was calculated by the method developed by J. C. Slater; for $Z \geq 72$, a similar, relativistic potential was used. The finite dimensions of the nucleus were calculated on the basis of the model of a uniformly charged sphere. Comparison of the newly obtained tables with the earlier ones revealed that the theoretical K-capture probability within a 0.5% limit does not depend on the chosen atomic potential, but the L-capture probability is more sensitive toward that potential. The effect of the finite dimensions on the functions which determine the K-capture probability is illustrated graphically. (TTT)

42973 ENERGY LEVELS OF ODD NUCLEI. Korolev, A. M. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 72-7(Jan. 1969). (In Russian).

In the ranges $60 \leq A \leq 150$ and $190 \leq A \leq 220$, near the magic numbers, there are nuclei for which the interaction of the extra nucleon of odd nuclei with the core is not sufficiently strong to affect the equilibrium spherical shape of the nucleus; only superficial oscillations are induced around the spherical shape. On this basis, the eigenfunctions and energy levels of odd nuclei were examined, using the Tamm–Dancoff method. It was assumed that the nucleus consists of an even–even core and a nucleon which interacts with it and excites in it a large number of phonons. The calculations were based on the eigenvalues of the one-particle Hamiltonian, the one-particle potential, and the Hamiltonian of the superficial oscillations of the nucleus. (TTT)

42974 A METHOD FOR MEASURING THE EXCITATION FUNCTION FOR INELASTIC NEUTRON SCATTERING. Musaelyan, R. M.; Popov, V. I.; Surkova, I. V.; Shtranikh, I. V. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 48-52(Jan. 1969). (In Russian).

The precise measurement of the energy dependence of the inelastic neutron scattering cross section near the excitation threshold of the levels is of great interest. In order to carry out such measurements, a method was developed for determining the energy dependence of the excitation cross section of the first two 2^+ levels of several even–even nuclei at neutron energies about 100 keV above the threshold. The method requires less than a gram-atom of the isotope to be examined. An electrostatic accelerator was used as neutron generator; the γ quanta were measured by means of a scintillation spectrometer provided with NaI(Tl) crystal, shielding the detector from a direct neutron beam by a tungsten–nickel cone. The neutron source was derived from the $T(p,n)^3He$ reaction. The protons, accelerated by the electrostatic generator, bombarded a titanium–tritium target and the neutrons were recorded by a counter placed at 30° with respect to the proton beam. The signals from the neutron monitor counter were processed at the measurement recording center of the Institute. A relay system was used to synchronize and control the experiments. Study of the excitation functions of $(n,n'\gamma)$ reactions revealed that the device may be used to determine relatively weak γ lines. (TTT)

42975 CONTRIBUTION TO THE THEORY OF COLLECTIVE EXCITATIONS OF NUCLEAR MATTER. Akhiezer, A. I.; Akhiezer, I. A.; Barts, B. I. Zh. Eksp. Theor. Fiz., 56: 2081-6(June 1969). (In Russian).

Volume collective excitations of nuclear matter are investigated taking into account the electromagnetic interaction between nucleons. It is shown that electromagnetic interaction leads to a coupling between density oscillations and charge oscillations and significantly modifies the collective excitation spectrum in the long-wave region. (auth)

42976 A NEW APPROACH TO THE THEORY OF SPHERICAL NUCLEI: THE SELF-CONSISTENT CORE–PARTICLE COUPLING METHOD. Dreiss, Gerard Julius. Philadelphia, Univ. of Pennsylvania, 1968. 121p.

Thesis.

Recent experimental results, the measurement of large static quadrupole moments in the first 2+ states of nuclei usually considered spherical, have cast doubt on the phenomenological model of collective nuclear vibrations. This lends interest to attempts to formulate microscopic models of collective motion in atomic nuclei. One such approach, the self-consistent core-particle coupling method, is developed and applied to even-even nuclei in the region $100 \leq A \leq 124$. The equations of this method, which is also known as the generalized Hartree–Fock approximation of Kerman and Klein, follow from the spectral decomposition of matrix elements of the equations of motion for single particle creation and annihilation operators. A set of coupled matrix eigenvalue equations, whose eigenvectors are made up of single particle coefficients of fractional parentage (cfp) connecting even-even core nuclei to neighboring odd nuclei emerge. The matrices themselves depend only on single particle and core properties. It is demanded that the core properties which appear be selfconsistent when calculated using the cfp. The solution is found by an iterative method. The problem is rendered tractable to calculation by drastically limiting the configuration space. This truncation is justified by the argument that certain sums must be approximately exhausted because of the physical nature of the collective motion in the nuclei we study. A number non-conserving approximation similar to that of the BCS theory is used. Self-consistent solutions were found, using the pairing-plus-quadrupole force Hamiltonian, for a severely truncated space, including only the ground and first 2+ states in the core nuclei. The results, then, can only be crude, but appreciable self-consistent quadrupole moments for the 2+ states were found, though smaller than present experimental values. The energy spectra of the neighboring odd nuclei, which appear as the eigenvalues of the equations are comparable to the previous calculations of Kisslinger and Sorensen. Inclusion of the higher "two phonon" states in a crude approximation improves the agreement of the quadrupole moment with experiment. (Diss. Abstr.)

42977 ELECTRON SCATTERING, PHOTOEXCITATION, AND NUCLEAR MODELS. Ueberall, H. (Catholic Univ. of America, Washington, D. C.). Ergeb. Exakten Naturwiss., 49: 1-89(1969).

A review of the basic theory of electron scattering from nuclei and of photonuclear processes is presented, as well as a discussion of the analysis of electron scattering experiments. This includes cross sections in Born approximation, elastic scattering from nuclei for the study of nuclear moments, and continuum scattering. Particular attention is given to inelastic electron scattering with excitation of nuclear levels, both below and in the giant resonance region. Various theoretical models are discussed that describe excitations of nuclear states. (auth)

42978 ELECTRON SCATTERING FROM p-SHELL NUCLEI. Vinciguerra, D.; Stovall, T. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). Nucl. Phys., A132: 410-32(1969).

Existing high-energy electron scattering data on p-shell nuclei are analyzed using nuclear wave functions obtained by extending the Nilsson model to include the single-particle orbitals admixtures from higher major shells. Good fits are found for the electron form factors for elastic and low-lying inelastic scattering. Values of the deformation parameters, of the rms charge radii, and of the charge quadrupole moments are extracted. (auth)

42979 STUDY OF NUCLEON PRODUCTION IN PROTON–NUCLEUS INTERACTIONS AT AN INCIDENT MOMENTUM OF 1.2 GeV/c. Alard, Jean-Pierre (Laboratoire de Physique Nucleaire, Puy-de-Dome, France); Viallefont, Paul; Roche, Guy; Motta, Claude; Costilhes, Jean-Pierre; Cordaillat, Andre; Sicre, Alain. Compt. Rend., Ser. B, 268: 1276-9(May 12, 1969). (In French).

The Monte Carlo method is used to calculate the double differential distributions of nucleons emitted in proton–nucleus interactions at 1.2 GeV/c; the predictions obtained are compared with experimental results. (tr-auth)

42980 NEUTRON–PROTON SURFACE DELTA INTERACTION IN SPHERICAL ODD-MASS NUCLEI. Reya, E.; Baier, H. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). Acta Phys. Aust., 28: 272-8(1968).

Assuming an n-p surface delta residual interaction (SDI), a theory for calculating various physical quantities of spherical odd mass nuclei is developed. Formulas are based on the quasiparticle Tamm–Dancoff approximation. (auth)

42981 CONNECTION BETWEEN RADIATIVE PION CAPTURE AND AXIAL CURRENT IN NUCLEI. Ericson, M. (Massachusetts Inst. of Tech., Cambridge); Figureau, A. Nucl. Phys., B11: 621-33(1969).

A previous conjecture that the soft-pion limit in nuclei is essentially the Born approximation for the effective Hamiltonian is here proved for threshold pion photoproduction, in analogy to the case of pion charge exchange. This method provides the effective Hamiltonian $H_{eff} = (e/2f\pi)\ A \cdot \epsilon$ related to the axial current and independent of the impulse approximation. The finite pion mass introduces two kinds of deviations from the Born approximation of this effective Hamiltonian: (a) corrections to the Hamiltonian itself (for example the ρ contribution, the nuclear pole and the fermi motion.), (b) deviations from the Born approximation due to the distortion of the pion wave by the strong interaction. The role of the nuclear excited states is to transform the average distorted pion field into an effective field. A numerical application is made to the ^3He–t system. (auth)

42982 ON INDUCED DOUBLE NUCLEON EMISSION. I. THE GENERAL FORMALISM. Weber, H. J. (Univ. of Virginia, Charlottesville). Ann. Phys. (N. Y.), 53: 93-114(June 1, 1969). (ORO–2915–95).

A general formalism is described in terms of a partial wave analysis for two-nucleon potential scattering to treat the final state interaction between the emitted nucleon pair and the residual nucleus occuring in the high-energy photo-effect (γ,NN) and for the absorption (π^-,NN) of a bound pion inducing the emission of a nucleon pair. Energy distribution and angular correlation rates are studied. (auth)

42983 RESCATTERING CORRECTIONS IN RADIATIVE PION ABSORPTION. Guy, Reed; Eisenberg, J. M. (Univ. of Virginia, Charlottesville). Nucl. Phys., B11: 601-10(1969).

Rescattering corrections to radiative pion absorption in nuclei are considered. The rescattering process is known to make important contributions to the nuclear absorption of S orbit pions with two-nucleon ejection. The rescattering corrections are calculated both in perturbation theory and with an approach based on the actual pion-nucleus scattering length. For the detailed evaluation of nuclear matrix elements the particle-hole formalism is used, and it is assumed that odd-parity spin-isospin nuclear states are excited by the radiative absorption mechanism. The calculation shows that incoherent rescattering effects involving an excited nucleus in the intermediate state are of little importance. Retaining only the coherent rescattering, decreases are found in the transition rate of approximately 40% relative to the leading term for ^{16}O. The relationship between the calculation and analyses based on the use of an optical potential is presented. (auth)

42984 INELASTIC SCATTERING OF NUCLEONS ON SINGLE-HOLE-NUCLEI IN THE THEORY OF FINITE FERMI SYSTEMS. Wegmann, Gerd (Univ., Munich). Z. Phys., 226: 60-80(1969).

The inelastic scattering of nucleons on magic nuclei with a single hole is considered in the framework of the theory of finite Fermi systems. It is shown that the amplitude for the reaction $\mu, k \Rightarrow \nu, k'$, where $|\mu, \nu(A-1)\rangle := $ single hole states of the initial and final nuclei and $k := k, \sigma\tau$, is determined by the four pole vertex Γ of the two-particle Green function. The particle-hole equation for Γ is established and an approximate solution is discussed where the vertex is represented by a nonresonant and a sum of compound nucleus contributions. It is shown that the nonresonant part and the position and strengths of the compound nucleus contributions are determined by the same effective particle-hole interaction introduced by Migdal and coworkers in their semi-phenomenological description of the static properties of nuclei adjacent to magic ones. It is pointed out briefly that the theory of inelastic scattering on magic nuclei with one additional nucleon proceeds along the same line. A new set of parameters has to be introduced, however, because in this case the particle-particle equation for Γ has to be considered. (auth)

42985 BINDING ENERY OF EVEN NUCLEI. Eder, Gernot (Univ., Geissen, Ger.). Acta Phys. Austr., 28: 85-93(1968). (In German).

If a mass-dependent parameter is permitted in a Weizsäcker formula for the binding energy of even nuclei, it is shown that the Coulomb, symmetry, and surface parameters increase with the mass number. The sharp reduction of the Coulomb parameter in light nuclei was comprehensible by the contribution of the exchange integral. The symmetry parameter is larger in nuclei whose last protons and neutrons have different shells than in nuclei in which they have the same shell. The splitting of the isospin-independent binding energy fraction into a volume and a surface term is meaningful for nuclei with $A > 40$. In light and in heavy nuclei it is conspicuous that within one shell the parameter a_6 (A) increases linearly with the mass number. All characteristics of the Coulomb energy, symmetry energy, and the isospin-independent energy fraction deviate sharply from the proposals of the drop model and are understandable only in the framework of the shell model. (tr-auth)

42986 ABOUT A METHOD OF CALCULATION OF EFFECTIVE RESONANCE INTEGRALS. Kuleshov, A. I. At. Energ. (USSR), 26: 290-1(Mar. 1969). (In Russian).

Heuristic concepts were used for constructing a simple analytical expression representing an acceptable approximation for the two-parameter resonance integral. (R.V.J.)

42987 STATISTICAL THEORY OF NUCLEI. II. MEDIUM AND HEAVY NUCLEI. Brueckner, K. A.; Buchler, J. R.; Clark, R. C.; Lombard, R. J. (Univ. of California, San Diego). Contract No. AT(11-1)-GEN-10. Phys. Rev., 181: 1543-51 (May 20, 1969).

The total energies of finite nuclei are expressed as a functional $E[\rho_p, \rho_n]$ of the local proton and neutron densities ρ_p and ρ_n. The binding energies and densities of any nucleus are found by minimizing $E[\rho_p, \rho_n]$ with respect to ρ_p and ρ_n separately. The potential-energy functional is initially derived from a nuclear matter calculation but later adjusted to reproduce experimental binding energies. Results for light nuclei have already been reported, and here the calculation is extended to medium and heavy nuclei. Binding energies and mean radii are well reproduced but surface thicknesses are too large and rms radii too small. (auth)

42988 COULOMB FORCES IN THE THREE-BODY PROBLEM. Hamza, Khidhir A.-A.; Edwards, Steve (Florida State Univ., Tallahasee). Phys. Rev., 181: 1494-1502(May 20, 1969).

The Faddeev–Lovelace equations, describing three particles interacting via short-range separable potentials, are modified to include the case in which two of the particles are charged. The three-body amplitudes are split into pure Coulomb and Coulomb-distorted amplitudes, and a set of integral equations similar to Lovelace's are obtained for the Coulomb-distorted amplitudes. The pure Coulomb contributions are taken to be zero for rearrangement channels and are approximated by two-body Coulomb amplitudes for the elastic scattering channel. Numerical results for deuteron-induced reactions on ^{16}O are compared with experimental data, with encouraging results. (auth)

42989 ANTISYMMETRIZATION OF THE THEORY OF STRIPPING REACTIONS. McKellar, Bruce H. J. (Univ. of Sydney). Phys. Rev., 181: 1502-5(May 20, 1969).

The Butler–Hewitt–McKellar–May theory of stripping reactions is modified to take into account the blocking effect of particle-hole correlations in the core, which populate the final neutron state with probability $1-P$. The basic relation of the theory between the direct-reaction matrix element M_C and the continuum matrix element M_S is altered to $M_C = S_k(P-S)^{-1}M_S$. (auth)

42990 ISOTOPE SHIFT OF NUCLEAR CHARGE DISTRIBUTIONS. Brueckner, K. A.; Lin, Wing-fai; Lombard, R. J. (Univ. of California, San Diego, La Jolla). Contract No. AT (11-1)-GEN 10. Phys. Rev., 181: 1506-11(May 20, 1969).

The energy-density formalism is applied to the study of the isotope shift of nuclear charge distributions. It allows the determination of the part of the shift due to a statistical change in the proton densities. The study is improved by a shell-model calculation based on the Thomas–Fermi potential. The charge distributions are in relatively good agreement with experiment. However, the present model cannot reproduce the part of the shift due to nonmonotonic changes in charge distributions. These nonmonotonic effects are of a more complicated origin; they are of the same order of magnitude as the statistical shifts. In the case of the pair of $^{40}Ca-^{48}Ca$ the results are consistent with shifts calculated in self-consistent (Hartree–Fock) methods. (auth)

42991 VELOCITY-DEPENDENT POTENTIALS IN THE HEISENBERG PICTURE. Kiang, D.; Nakazawa, K., Sugano, R. (Dalhousie Univ., Halifax, Can.). Phys. Rev., 181: 1380-2 (May 20, 1969).

Velocity-dependent potentials are investigated in both the Langrangian and Hamiltonian formalisms. A canonical transformation is introduced so that a consistent formulation is achieved. It is found that the proper Hamiltonian operator should be $H = K + {}^1/_{16}\, f^{-1}(r)[f'(r)]^2$ rather than the customarily used form of $K = {}^1/_2 p \cdot f(r)\, p + V(r)$. (auth)

42992 PARTICLE AND PHOTON DECAY OF NUCLEI FOLLOWING ELECTROEXCITATION. Drechsel, Dieter (Catholic Univ. of America, Washington, D. C.); Ueberall, H. Phys. Rev., 181: 1383-95(May 20, 1969).

Angular-correlation formulas are derived for a coincidence experiment in which an electron scattered inelastically by a nucleus is detected simultaneously with a heavy particle or photon emitted by the nucleus subsequently to its electroexcitation. The excitation of the nucleus is treated in first Born approximation, i.e., single-photon exchange between electron and nucleus is assumed. The subsequent decay depends on the properties of the emitted particle. Within the framework of the one-level resonance model (i.e., assuming that the level matrix is diagonal), the formulas derived are valid for heavy-particle as well as photon decay. Only slight modifications are necessary, however, to take into account properly the effects of coupled channels for particle decay. The present results differ from those of a previous investigation in that (a) overlapping excited levels are included, as found in most applications (we assume, however, that the level matrix is diagonal), (b) photons as well as spin-½ and spin-0 particles are considered as being emitted in the nuclear decay, and (c) summations over all magnetic quantum numbers were carried out. Examples considered were excitations of isolated E1 and M1 levels of a spinless nucleus, and of the overlapping E1 giant resonance levels of ^{12}C, evaluated by R-matrix theory. (auth)

42993 INELASTIC PROCESSES IN PARTICLE TRANSFER REACTIONS. Ascuitto, R. J.; Glendenning, Norman K. (Univ. of California, Berkeley). Phys. Rev., 181: 1396-1403(May 20, 1969).

It must certainly be true for some levels in all nuclei, and all levels in some nuclei that the usual treatments of particle-transfer reactions, which neglects inelastic effects, is invalid. A practical method for taking these effects into account is described. The method is discussed in terms of the (d,p) reaction, but it has a much broader application. (auth)

42994 MOMENT OF INERTIA IN HARTREE–FOCK THEORY. Banerjee, M. K.; d'Oliveira, Diogenes; Stephenson, G. J. Jr.

(Univ. of Maryland, College Park). Contract No. ORO-3765-7. Phys. Rev., 181: 1404-14(May 20, 1969).

The conditions under which a Hartree–Fock wave function may be a good description of the intrinsic state of a rotational nucleus are discussed from two points of view; first by studying the fluctuations of the modified Hamiltonian $H-\alpha J^2$ as a function of α, and second by studying the response of the wave function to a small external perturbation—ωJ_x. Following Thouless and Valatin, this response is given in terms of an anti-Hermitian cranking operator S. It is demonstrated that, when the Hartree–Fock wave function is adequate, S is of the form $[J_x,\rho]/\epsilon$, where ρ is the single-particle density operator and ϵ is twice the rotational energy content of the intrinsic state. These considerations lead to simple tests of the adequacy of the Hartree–Fock wave function as a rotational intrinsic wave function. A comparative study of various formulas for the moment of inertia, utilizing the aforementioned result for S, is presented. (auth)

42995 FLUCTUATIONS IN NUCLEAR ELASTIC SCATTERING CROSS SECTIONS. Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 181: 1414-21(May 20, 1969).

A method of fluctuation analysis is developed for elastic scattering of spin-zero particles from spin-zero nuclei. The principal difference between this model and the one proposed by Ericson is that some unitarity is included. It is shown that all features of conventional fluctuation analysis are modified to a small extent. Analysis of the phase shift may show entirely different behavior from that predicted by an Ericson model. Because of the simplicity of the elastic-scattering reaction, it is possible to obtain not only the total width but also the level spacing and partial width (as defined within the context of the model). These quantities are obtained as a function of angular momentum. This method is only applicable if a phase-shift analysis can be done on the data. (auth)

42996 CORRELATIONS AND DISTRIBUTIONS OF WIDTHS IN RESONANCE NEUTRON CAPTURE. Beer, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 181: 1422-7(May 20, 1969).

Two-channel moments of amplitudes are calculated for a model in which the compound-nuclear wave function consists of the sum of two vectors each randomly oriented on the surface of its own hypersphere. The relative variances of partial radiation widths and of reduced neutron widths are calculated. Expressions are found for the correlation coefficient of reduced neutron widths and partial radiation widths, and for the correlation coefficient of partial radiation widths to pairs of bound states. It is found that the relative variance value 2 for reduced neutron widths, as well as recent experimental findings for the statistics of partial widths, can be incorporated in the present two-group model if one of the groups is composed of a vector space of a large number of dimensions. (auth)

42997 EIGENSTATES OF THE L = 0 CHARGE- AND SPIN-INDEPENDENT PAIRING HAMILTONIAN. II. Seniority-1 STATES. Richardson, R. W. (New York Univ.). Phys. Rev., 181: 1431-43(May 20, 1969).

Equations for all the seniority-1 states of 2N + 1 nucleons in an arbitrary charge- and spin-independent single-particle potential and interacting through an L = 0 charge- and spin-independent pairing interaction are derived. These equations are then solved analytically for a large number of physically interesting states. These states are characterized by having wave functions that are totally symmetric functions of the spin-isospin variables of the N, L = 0 pairs of nucleons in the state. The supermultiplet quantum numbers of these states are given by $P = 1/2, 3/2, \ldots, N + 1/2$, $P' = 1/2$, $P'' = \pm 1/2$. The wave function of these states is shown to factor into a spin-isospin part times an orbital part. The spin-isospin part of the wave function is shown to satisfy three eigenvalue problems which insure that the state is a supermultiplet, spin, and isospin eigenstate, respectively. The eigenvalues of these three problems are given explicitly in terms of the quantum numbers of the state. The orbital part of the wave function is given analytically in terms of N parameters which we call pair energies. These pair energies are shown to satisfy N coupled nonlinear algebraic equations which depend parametrically upon the interaction strength, single-particle spectrum, and the supermultiplet quantum numbers of the state. Explicit expressions for the energies of the states and the occupation probabilities of the single-particle levels are given in terms of the pair energies. These expressions may be evaluated with ease for values of the parameters that are characteristic of light-weight nuclei. (auth)

42998 NUCLEAR-MATTER RADII FROM ANALYSIS OF 14.5-MeV PROTON AND NEUTRON SCATTERING. Pyle, G. J.; Greenlees, G. W. (Univ. of Minnesota, Minneapolis). Phys. Rev., 181: 1444-54(May 20, 1969).

The optical model of Greenlees, Pyle, and Tang was used to fit 14.5-MeV neutron elastic-scattering data. Excellent fits are obtained and the results of this neutron analysis are compared with results obtained from an analysis of 14.5-MeV proton elastic data for the same elements. The neutron analysis shows the same features as are found in the proton analysis, and the nuclear matter rms radii and the volume integrals of the two-body force obtained from the neutron analysis are in excellent agreement with the corresponding values obtained from the analysis of proton data. (auth)

42999 COMPARISON OF DIFFERENT NUCLEAR MASS FORMULAE. Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). Nucl. Phys., A133: 438-44(1969).

Many nuclear mass formulas based on the isotopic invariance principle have been proposed during the last few years (Goldanskii, Wilkinson, Garvey and Kelson, Jänecke). These formulas found successful applications in the predictions of properties of many neutron-deficient and neutron-excessive isotopes of light and intermediate elements. Systematic comparison of such formulas is given and the degree of their precision is estimated. (auth)

43000 THE DENSITY MATRIX OF NUCLEI ADJACENT TO MAGIC NUCLEI IN THE THEORY OF FINITE FERMI SYSTEMS. Wegmann, G. (Univ., Munich). Nucl. Phys., A133: 405-9(1969).

Migdal's statement on the change of the density matrix upon adding a nucleon to a magic nucleus is proved and extended to the case when a nucleon is removed from a magic nucleus ("addition of a nucleon hole"). (auth)

43001 ENERGY OF NON-AXIAL DEFORMATION OF HEAVY NUCLEI. Pashkevich, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A133: 400-4(1969).

The total energy of nuclei in the actinide region was calculated according to nonaxial deformation by the Strutinsky method. Stability to γ-deformation is shown for both first and second minima of the potential energy curve. Stiffness of γ-vibrations is considerably larger for the second minimum than for the first one. The saddle point between the two minima is found to be shifted to $\gamma \approx$ 5 to 10°. (auth)

43002 CORRECTIONS TO THE BETHE–HEITLER FORMULAE FOR BREMSSTRAHLUNG AND PAIR PRODUCTION. Deck, R. T. (Univ. of Toledo); Moroi, D. S.; Alling, W. R. Nucl. Phys., A133: 321-33(1969).

Correction terms of order αZ to the Bethe–Heitler formulas for the bremsstrahlung and pair production cross sections are derived in an unscreened point Coulomb field in a surprisingly simple and symmetric form. (auth)

43003 SINGLE-PARTICLE STATES IN A DEFORMED ENERGY-DEPENDENT POTENTIAL. APPLICATION TO ^{183}W. Vogeler, Johannes-Heinrich (Univ., Frankfurt am Main). Nucl. Phys., A133: 289-309(1969).

The nucleon wave functions and energy eigenvalues in a deformed Woods–Saxon potential are calculated approximately by diagonalizing the Hamiltonian in a finite subspace of Hilbert space. The potential is assumed to be axially symmetric and symmetric with respect to inversion, its depth is made energy dependent to take into account the non-local nucleus-nucleon interaction. With the pairing theory of residual interaction, these results are used to calculate the energy of single-particle excited states in the equilibrium deformation of ^{183}W. The good agreement with experiment shows that the nuclear shape is more cylindrical than ellipsoidal as has been anticipated in former calculations. Rotational bands are studied considering the influence of band mixing, and electromagnetic properties are calculated. (auth)

43004 CHARGE FORM FACTOR OF THE ALPHA PARTICLE. Singh, R. P.; Raj, Ram; Rustgi, M. L. (State Univ. of New York, Buffalo). Nucl. Phys., A133: 365-8(1969).

Employing a wave function of the alpha particle (^{4}He), containing a mixture of $^1S_0$ and the principal $^5D_0$ states, an analytical expression for the charge form factor $F_E(q^2)$ is calculated. The theoretical values of $F_E(q^2)$ are compared with those obtained from electron-helium scattering experiments. Though the wave function employed in the calculation gave good fits to the binding energy bremsstrahlung-weighted and integrated cross sections for the photodisintegration of helium it failed to give agreement with $F_E(q^2)$. (auth)

43005 SHELL-MODEL MATRIX ELEMENTS FROM A REALISTIC POTENTIAL. Lawson, R. D. (Weizmann Inst. of Science, Rehovoth, Israel. Argonne National Lab., Ill.); Soper, J. M. Nucl. Phys., A133: 473-80(1969).

A new method of calculating the effective matrix elements of a "realistic" two-body interaction is presented. It is assumed that the unperturbed energies of the single-particle states are those of a harmonic oscillator. For two particles outside an inert core, the problem can in some instances be solved exactly; in other cases, it is necessary to approximate the Pauli principle (in a way that is later shown to be justified). The theory is applied to ^{6}He, and for interaction energies involving relative s-state motion, the matrix elements are about 20% more attractive than those computed by use of the bare G-matrix. Since the G-matrix calculations assume free-particle energies for states outside the model space, this difference gives some measure of the sensitivity of the computed T = 1 matrix elements to assumptions about the single-particle energies used in intermediate states. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 41573, 41714, and 43086.

43006 (BNWL-1122) ANALYSIS OF YANKEE-ROWE BURNUP DATA. Matsen, R. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

Burnup data from the Yankee Core Evaluation Program have been converted to isotopic concentrations in nuclei per barn-centimeter, analyzed for cross section information by least squares fitting techniques, and compared with the predictions of the RIBOT and ZODIAC G burnup codes. The Pu-U burnup equations used for the least squares analysis of the data are developed and discussed. Data from additional Yankee samples measured primarily for information about the rarer heavy metal isotopes (^{237}Np, ^{236}Pu, ^{238}Pu, ^{241}Am, ^{243}Am, ^{242}Cm, and ^{244}Cm) are also presented. The ^{242}Pu → ^{243}Am → ^{244}Cm chain has also been analyzed for cross section information. 12 references. (auth)

43007 (DOCKET-1151-2) ELK RIVER REACTOR. Monthly Operation Report No. 81, July 1969. (Rural Cooperative Power Association, Elk River, Minn.). Aug. 25, 1969. 15p. (COO-651-77). Dep. CFSTI.

43008 (DOCKET-50003-3) INDIAN POINT NUCLEAR GENERATING UNIT NO. 1. License No. DPR-3; Unusual Occurrence Report on Flux Computer. (Consolidated Edison Co. of New York, Inc., New York). Aug. 22, 1969. 2p. Dep. CFSTI.

Several down spikes in the average power signal are recorded. Effects and causes of the down-spikes are evaluated. (M.L.S.)

43009 (DOCKET-50016-6) ENRICO FERMI ATOMIC POWER PLANT. [Monthly] Report, June 1969. (Power Reactor Development Co., Detroit, Mich.). 9p. (PRDC-EF-70). Dep. CFSTI.

43010 (DOCKET-50016-7) ENRICO FERMI ATOMIC POWER PLANT. License No. DPR-9: Technical Specifications, Change No. 17. (Power Reactor Development Co., Detroit, Mich.). Aug. 18, 1969. 5p. Dep. CFSTI.

FERMI FAST BREEDER REACTOR—fuel element storage at, safety evaluation auxiliary irradiated (M.L.S.)

43011 (DOCKET-50016-8) ENRICO FERMI ATOMIC POWER PLANT. License No. DPR-9: Additional Information on the Fuel Melting Incident, Plans for Startup and Power Ascension, and Proposed Changes to the Technical Specifications. (Power Reactor Development Co., Detroit, Mich.). Aug. 20, 1969. 230p. Dep. CFSTI.

Details relating to the fuel melting incident at the Fermi Fast Breeder Reactor are given. The possibility of fuel element subassembly voiding and refilling is evaluated. Core subassembly temperatures are given for the October 5, 1966, incident; a comparison of measured and calculated data are shown graphically. The possibility of additional small foreign objects being in the coolant system is evaluated. A hypothetical flow blockage accident is analyzed. Core heat transfer requirements are reviewed with respect to solubility of gases in alkali metals at high temperatures. Hypothetical accident types are reviewed. The proposed restartup test program is outlined. Radiation emergency procedures are detailed. Revisions or additions to technical specifications, and their corresponding justifications are included. (M.L.S.)

43012 (DOCKET-50016-9) ENRICO FERMI ATOMIC POWER PLANT. REACTIVITY CHANGES IN MELTDOWN CONFIGURATIONS OF FERMI CORE A FUEL. (Atomic Power Development Associates, Inc., Detroit, Mich.). June 1969. 46p. (APDA-LA-1). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Effects on reactivity of various Fermi Fast Breeder Reactor fuel meltdown configurations are evaluated. Melting required to introduce positive reactivity effects is determined. The range of validity of perturbation theory predictions of reactivity changes for fuel melting is calculated. The parametric studies on the various meltdown geometries and the computational and analytic methods utilized are discussed. (M.L.S.)

43013 (DOCKET-50016-10) ENRICO FERMI ATOMIC POWER PLANT. SUBASSEMBLY THERMOCOUPLE ANALYSIS FOR THE FUEL MELTING INCIDENT IN THE ENRICO FERMI REACTOR. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 44p. (APDA-LA-2). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

An evaluation of the thermocouple readings of core outlet coolant temperature during the fuel meltdown incident in the Fermi Fast Breeder Reactor is given. The instrumentation and location of the thermocouples are described. Preincident and postincident analyses of thermocouple readings are detailed. Chart readings and temperature histories are included. (M.L.S.)

43014 (DOCKET-50016-11) ENRICO FERMI ATOMIC POWER PLANT. DESIGN AND CAPABILITIES OF THE MALFUNCTION DETECTION ANALYZER INSTALLED ON THE ENRICO FERMI FAST BREEDER REACTOR. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 76p. (APDA-LA-3). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

The selection and description of a real-time computer system for prompt, reliable detection of any future malfunctions in the Fermi Fast Breeder Reactor are detailed. The computer installation, programs, and checkout methods are described. Detection limits and calculation frequencies are given. A literature survey of malfunction detection systems that are being or will be employed at various reactor installations is included. 19 references. (M.L.S.)

43015 (DOCKET-50016-12) ENRICO FERMI ATOMIC POWER PLANT. INSPECTION OF THE CORE HOLDDOWN OF THE ENRICO FERMI REACTOR. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 61p. (APDA-LA-4). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Details of the inspection of the holddown mechanism (HDM), subsequent to the fuel melting incident in the Fermi Fast Breeder Reactor, are given. Methods used in inspection are described; alignment of the HDM is evaluated. Inspection results are tabulated as a function of holddown finger. (M.L.S.)

43016 (DOCKET-50016-13) ENRICO FERMI ATOMIC POWER PLANT. THERMAL-HYDRAULIC ANALYSIS OF THE OCTOBER 5, 1966 FUEL MELTING INCIDENT IN THE ENRICO FERMI REACTOR. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 92p. (APDA-LA-5). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Thermal-hydraulic aspects of the October 5, 1966, fuel melting incident in the Fermi Fast Breeder Reactor are analyzed in detail. The amount of flow blockage and the power level at which the fuel melted are calculated; the melting process is described. Final conditions in the fuel plug region and in the core region of the melted subassemblies are numerically simulated. Results of calculations are extrapolated to higher reactor power levels and other coolant-flow-blockage conditions. 23 references. (M.L.S.)

43017 (DOCKET-50016-14) ENRICO FERMI ATOMIC POWER PLANT. A STUDY OF GAS ENTRAINMENT AND ABSORPTION-DESORPTION IN THE ENRICO FERMI REACTOR AND THEIR EFFECT ON CORE PERFORMANCE. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 50p. (APDA-LA-6). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

The possible presence of gas in the primary coolant of the Enrico Fermi Reactor and its effect on core heat transfer are discussed. Gas could be slowly introduced into the primary system by gas bubble entrainment and/or differential temperature solubility between the hot and cold portions of the primary system. A few potential sites for the accumulation of this gas have been found and the maximum accumulated volumes and rates of gas release from these sites determined. The effect of a single large bubble and also the continuous presence of gas on the core heat transfer have been studied. 19 references. (auth)

43018 (DOCKET-50016-15) ENRICO FERMI ATOMIC POWER PLANT. SUMMARY OF ENERGY RELEASE ANALYSES OF THE HYPOTHETICAL MELTDOWN DESIGN ACCIDENT FOR CORE A OF THE ENRICO FERMI REACTOR. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 30p. (APDA-LA-7). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

A review of the analyses of energy release in a hypothetical fuel meltdown accident for the Fermi Fast Breeder Reactor core. The analyses used in the original safety analyses were used as reference. Improved models for the formulation of equations of state, treatment of the Doppler coefficient, specification of reactivity insertion rate, models for geometry simulation and incident initiation, and calculations of available work in isentropic expansions of fuel-sodium mixtures to selected pressures (a form of sodium vapor explosion). Effects on the Fermi containment structures are evaluated. A printout of the program used for the sodium vapor explosion work calculations is included. 15 references. (M.L.S.)

43019 (DOCKET-50016-16) ENRICO FERMI ATOMIC POWER PLANT. FLOW GUARDS FOR CORE A SUBASSEMBLIES IN THE ENRICO FERMI ATOMIC POWER PLANT. (Atomic Power Development Associates, Inc., Detroit, Mich.). July 1969. 35p. (APDA-LA-8). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Devices to protect the fuel against coolant flow starvation by a flat plate will be installed in subassemblies of the high-pressure plenum of the Fermi Fast Breeder Reactor. The devices designated as flow guards will be securely attached to the inlet nozzles of all Core A and inner radial blanket subassemblies prior to loading in the reactor. In principle, the device is an extension of the subassembly below the support plate. The design description of the flow guards is given, together with the results of the test program that confirmed the operating characteristics of the flow guards under simulated in-reactor conditions. A description is also given of the satisfactory results obtained from analyses that determined the effects of using flow guards on the operating and safety characteristics of the reactor. The analyses included fuel performance, changes necessary in the design of the reactor, changes created in the system hydraulics, and the effects on the safety of the system. (auth)

43020 (DOCKET-50016-17) COOLANT BLOCKAGE TO A FERMI CORE A CENTRAL SUBASSEMBLY AT TWO POWER LEVELS. (Nuclear Technology Corp., White Plains, N. Y.). July 1, 1969. 72p. (NTC-1016-6). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Effects of sudden coolant flow blockages to a Fermi Fast Breeder Reactor core subassembly are evaluated as a function of power. Propagation rate for melting, reactivity changes, and fuel dispersions are analysed, in detail, as possible consequences of hypothetical fuel melting. Data and results of calculations are shown graphically. (M.L.S.)

43021 (DOCKET-50016-18) COOLANT BLOCKAGE TO A FERMI CORE A CENTRAL SUBASSEMBLY. PART 2. CONDITIONS LEADING TO FUEL MELTING AND REACTOR SCRAM. (Nuclear Technology Corp., White Plains, N. Y.). July 1, 1969. 49p. (NTC-1016-7). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

The analytical model developed for analysing the consequences of sudden coolant flow blockage to a Fermi Fast Breeder Reactor fuel element subassembly is used for analysis over a broad range of operating conditions. Conditions under which fuel melting will not occur are determined; conditions where fuel melting occurs, accompanied by reactor scram are analysed. (M.L.S.)

43022 (DOCKET-50016-19) STRUCTURAL RESPONSE OF A FERMI SUBASSEMBLY WRAPPER CAN AND SAFETY ROD GUIDE TUBE TO PRESSURE PULSES. (Nuclear Technology Corp., White Plains, N. Y.). Apr. 13, 1969. 61p. (NTC-1016-5). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

The structural response of a subassembly wrapper can which is subjected to an internal pressure is analysed for the Fermi Fast Breeder Reactor. Minimum pressure pulse magnitudes and durations which lead to accident propagation are calculated. Thresholds for gross deformation or failure are determined. Quasi-static and impulse loading conditions are evaluated. Effects on the subassembly wrapper can and safety rod guide tubes are analysed. (M.L.S.)

43023 (DOCKET-50029-95) YANKEE NUCLEAR POWER STATION. Operation Report No. 103, July 1969. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 18, 1969. 7p. Dep. CFSTI.

43024 (DOCKET-50029-96) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 89. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 25, 1969. 7p. Dep. CFSTI.

Removal of test fuel assemblies from the Core VIII loading in the Yankee Power Reactor is discussed. Thermal, hydraulic, and nuclear analyses are given; design data are tabulated. (M.L.S.)

43025 (DOCKET-50029-97) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 88. (Yankee Atomic Electric Co., Boston, Mass.). Aug. 26, 1969. 3p. Dep. CFSTI.

Use of the spent fuel shipping cask to transfer irradiated fuel elements from the Yankee core during unloading-reloading activities is discussed. Damage to the fuel transfer carriage caused the regular system to be out of service. A safety evaluation of these alternate procedures is given. (M.L.S.)

43026 (DOCKET-50155-11) [BIG ROCK POINT NUCLEAR PLANT]. License No. DPR-6, Amendment 3. Technical Specifications, Change No. 17. (Consumers Power Co., Jackson, Mich.). Apr. 18, 1969. 14p. Dep. CFSTI.

The use of PuO_2-UO_2 fuel rods in the Big Rock Point Power Reactor is evaluated. Design parameters are tabulated for the fuel elements. (M.L.S.)

43027 (DOCKET-50155-12) [BIG ROCK POINT NUCLEAR PLANT]. License No. DPR-6. Technical Specifications, Change No. 18. (Consumers Power Co., Jackson, Mich.). Apr. 24, 1969. 6p. Dep. CFSTI.

Operation of the Big Rock Point Power Reactor with fuel bundles containing up to 24 removable fuel rods is discussed. A safety evaluation of this operational mode is included; design parameters of the new fuel elements are given. (M.L.S.)

43028 (DOCKET-50171-8) PEACH BOTTOM ATOMIC POWER STATION, [UNIT NO. 1]. Monthly Operations Report No. 40, June 1969. (Philadelphia Electric Co., Pa.). Aug. 18, 1969. 15p. Dep. CFSTI.

43029 (DOCKET-50184-15) NATIONAL BUREAU OF STANDARDS REACTOR. Operations Report No. 5, April-June 1969. (National Bureau of Standards, Washington, D. C.). Aug. 25, 1969. 14p. Dep. CFSTI.

43030 (DOCKET-50206-19) SAN ONOFRE NUCLEAR GENERATING STATION, [UNIT 1]. Semiannual Operating Report No. 4, January 1-June 30, 1969. (Southern California Edison Co., Camp Pendleton, Calif. San Diego Gas and Electric Co., Calif.). July 31, 1969. 8p. Dep. CFSTI.

43031 (DOCKET-50213-16) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 69-7, July 1969. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Aug. 12, 1969. 12p. (NYO-3250-37). Dep. CFSTI.

43032 (DOCKET-50214-1) MALIBU NUCLEAR PLANT, UNIT NO. 1. Preliminary Hazards Summary Report, Part B. (Department of Water and Power, Los Angeles, Calif.). Nov. 1963. 330p. Dep. CFSTI.

MALIBU POWER REACTOR—site for, preliminary safety analysis of
—containment system for, preliminary safety analysis of
—core for, preliminary safety analysis of design for
—cooling system for, preliminary safety analysis of design for
—emergency and auxiliary systems for, preliminary safety analysis of
—radioactive waste processing at, preliminary safety analysis of
—shielding for, preliminary safety analysis of
—control systems and instrumentation for, preliminary safety analysis of
—steam and power conversion system for, preliminary safety analysis of
—electrical systems for, preliminary safety analysis of
—operation of, preliminary safety analysis of proposed
—safety analyses of, preliminary
—site for, detailed meteorologic, seismologic, and subsurface data for (M.L.S.)

43033 (DOCKET-50219-25) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. [Facility Description and Safety Analysis Report], Amendment 47. (Jersey Central Power and Light Co., Morristown, N. J.). Oct. 31, 1968. 2p. Dep. CFSTI.

The results of the post-hydrostatic testing of the Oyster Creek Power Reactor, Unit 1 pressure vessel are summarized. A list of references to detailed information on the various inspections is included. (M.L.S.)

43034 (DOCKET-50220-27) NINE MILE POINT NUCLEAR STATION. Provisional Operating License No. DPR-17. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Aug. 22, 1969. 146p. Dep. CFSTI.

The provisional operating license, detailed technical specifications, and design bases for the Nine Mile Point Power Reactor are included. The license for the single unit BWR authorizes steady state operation at power levels up to 1538 MW(t). A transfer schedule for the special nuclear materials is included, also. (M.L.S.)

43035 (DOCKET-50237-12) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Supplementary Information, Amendment 17 for Unit 2 and Amendment 18 for Unit 3. (Commonwealth Edison Co., Chicago, Ill.). Aug. 18, 1969. 23p. (DOCKET-50249-13). Dep. CFSTI.

Comparison of the rod block monitor design for Dresden Power Reactor, Units 2 and 3 with the IEEE 279 standard is made. The circuitry for the flow-reference scram is described; conformance with IEEE standards is discussed. Stack monitoring capability is assessed. Specifications and test results are given for the main steam line containment isolation valve; leakage rates of isolation valves are discussed in detail. (M.L.S.)

43036 (DOCKET-50247-6) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. DESCRIPTION OF SITE AND ENVIRONMENT. Preliminary Safety Analysis Report, Exhibit B, Vol. 1. (Consolidated Edison Co. of New York, Inc., New York). Dec. 7, 1965. 240p. Dep. CFSTI.

INDIAN POINT POWER REACTOR, UNIT 2—site for, preliminary safety analysis of (M.L.S.)

43037 (DOCKET-50247-7) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. PLANT DESIGN DESCRIPTION AND SAFETY ANALYSIS. Preliminary Safety Analysis Report, Exhibit B, Vol. 2, Part A. (Consolidated Edison Co. of New York, Inc., New York). Dec. 7, 1965. 248p. Dep. CFSTI.

INDIAN POINT POWER REACTOR, UNIT 2—core for, preliminary safety analysis of design for
—cooling system for, preliminary safety analysis of design for
—containment system for, preliminary safety analysis of
—engineered safeguards for, preliminary safety analysis of
(M.L.S.)

43038 (DOCKET-50247-8) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. PLANT DESIGN DESCRIPTION AND SAFETY ANALYSIS. Preliminary Safety Analysis Report, Exhibit B, Vol. 2, Part B. (Consolidated Edison Co. of New York, Inc., New York). Dec. 7, 1965. 306p. Dep. CFSTI.

INDIAN POINT POWER REACTOR, UNIT 2—control systems and instrumentation for, preliminary safety analysis of
—electrical system for, preliminary safety analysis of
—emergency and auxiliary systems for, preliminary safety analysis of,
—steam and power conversion system for, preliminary safety analysis of
—radiation protection and radioactive waste processing at, preliminary safety analysis of
—safety evaluation of,
—fuel rods for, operating experience with high power level
—core for, reactivity coefficients and spatial stability of
(M.L.S.)

43039 (DOCKET-50255-19) PALISADES PLANT. Preliminary Safety Analysis Report, Amendment 15. (Consumers Power Co., Jackson, Mich.). Aug. 26, 1969. 243p. Dep. CFSTI.

Supplementary information on the removal of the thermal shield from the Palisades Power Reactor is given. Details are given on the preoperational environment monitoring program; locations of monitoring stations are shown; results of analyses already performed are tabulated. Lake Michigan hydrology in the Palisades site area is described; dilution of plant liquid waste in Lake Michigan is evaluated. Results of core mockup tests are detailed. Design criteria and materials for the containment and auxiliary buildings are tabulated. Dynamic analysis procedures for the containment internal structures are described; the mathematical models used for the seismic design of all Class I structures are detailed. A detailed description of the circuitry utilized in sequential control rod group movement is given; a schematic is included. Cable installation criteria are described; the quality assurance criteria for reactor instrumentation are listed. The mathematical models used in estimating primary coolant fission product and corrosion product activities are discussed. Objectives and acceptance criteria for preoperational and not functional tests are listed. Hydrogen accumulation following a hypothetical coolant loss accident is discussed; possible consequences are evaluated. Methods used in evaluating rod worths and peaking factors for a hypothetical control rod ejection accident are discussed. (M.L.S.)

43040 (DOCKET-50261-10) H. B. ROBINSON UNIT NO. 2. Final Safety Analysis Report, Amendment 8. (Carolina Power and Light Co., Raleigh, N. C.). Nov. 22, 1968. 8p. Dep. CFSTI.

A revised license application for the H. B. Robinson Power Reactor contains the organization and principal officers of the Carolina Power and Light Company. Projected ^{235}U requirements are tabulated. (M.L.S.)

43041 (DOCKET-50263-23) MONTICELLO NUCLEAR GENERATING PLANT, MONTICELLO, MINNESOTA, UNIT 1. Final Safety Analysis Report, Amendment 16. (Northern States Power Co., Minneapolis, Minn.). Aug. 22, 1969. 121p. Dep. CFSTI.

Details of the site and environmental monitoring plan for the Monticello Power Reactor are given. Pressure vessel design and inspection are detailed. Use of surface-carburized jet pump castings is discussed. Principal penetrations of the primary containment vessel and the associated isolation values are tabulated. Steam line and feedwater control instrumentation are discussed; schematics are included. The transmission lines emanating from the switchyard are discussed. Preoperational tests for the steam generator are described. A single failure analysis of the diesel generator emergency power system is given. Cable installation design criteria are detailed. The quality assurance program is discussed. (M.L.S.)

43042 (DOCKET-50312-9) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Suppl. 2. (Sacramento Municipal Utility District, Calif.). July 15, 1969. 110p. Dep. CFSTI.

The reinforcing steel and prestressing tendons for the Rancho Seco Power Reactor, Unit 1 containment structures are described. Details of the VSL post-tensioning system, procurement specifications for the prestressed concrete reactor building post-tensioning system, ultimate strength tests on VSL anchorages—including raw data, and the design of liner plate anchors are given. (M.L.S.)

43043 (DOCKET-50315-16) DONALD C. COOK NUCLEAR PLANT, UNITS NO. 1 AND 2. Construction Permits Nos. CPPR-60 and CPPR-61; Notice of Design Changes. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). Aug. 15, 1969. 4p. (DOCKET-50316-16). Dep. CFSTI.

Notice of minor design changes for the Donald C. Cook Power Reactor, Units 1 and 2 is given. The design changes pertain to the screen house, containment vessel liner anchorages, and essential service water system. (M.L.S.)

43044 (DOCKET-50324-13) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Carolina Power and Light Co., Raleigh, N. C.). Aug. 18, 1969. 160p. (DOCKET-50325-13). Dep. CFSTI.

Technical qualifications of Brown and Root, Inc. constructors of the Brunswick Power Reactor, Units 1 and 2 are detailed. The quality control and inspection programs are discussed. Personnel qualifications are summarized for the United Engineers and Contractors and for Brown and Root. (M.L.S.)

43045 (DOCKET-50327-6) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 3. (Tennessee Valley Authority, [Knoxville]). Aug. 12, 1969. 67p. (DOCKET-50328-6). Dep. CFSTI.

Detailed information on the Rotterdam Dockyard Company, supplier of the pressure vessel for the Sequoyah Power Reactor Units 1 and 2, is given. The design and manufacture of the pressure vessel are discussed; the quality control program is detailed. (M.L.S.)

43046 (DOCKET-50344-4) TROJAN NUCLEAR PLANT. Preliminary Safety Analysis Report, Amendment 1. (Portland General Electric Co., Oreg.). Aug. 25, 1969. 127p. Dep. CFSTI.

A detailed quality assurance program for the Trojan Power Reactor is given. This includes the programs for Portland (Oregon) General Electric Company, Bechtel, and Westinghouse. (M.L.S.)

43047 (DOCKET-50346-1) DAVIS-BESSE NUCLEAR POWER STATION. APPLICATION FOR LICENSES. (Toledo Edison Co., Ohio. Cleveland Electric Illuminating Co., Ohio). Aug. 1, 1969. 54p. Dep. CFSTI.

Directors and principal officers of the Toledo Edison Company and the Cleveland Electric Illuminating (CEI) Company, owners of the Davis-Besse Power Reactor, are listed. Financial qualifications of both companies are described; projected plant costs are given. The 1968 Annual Reports are included for both Toledo Edison and CEI. (M.L.S.)

43048 (DOCKET-50346-2) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Vol. 1. (Toledo Edison Co., Ohio). Aug. 1, 1969. 364p. Dep. CFSTI.

DAVIS-BESSE POWER REACTOR—sites for, preliminary safety analysis of
—core for, preliminary safety analysis of design for
(M.L.S.)

43049 (DOCKET-50346-3) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Vol. 2. (Toledo Edison Co., Ohio). Aug. 1, 1969. 208p. Dep. CFSTI.

DAVIS-BESSE POWER REACTOR—cooling system for, pre-

liminary safety analysis of design for
—containment system for, preliminary safety analysis of
—engineered safeguards for, preliminary safety analysis of
—control systems and instrumentation for, preliminary safety analysis of (M.L.S.)

43050 (DOCKET-50346-4) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Vol. 3. (Toledo Edison Co., Ohio). Aug. 1, 1969. 242p. Dep. CFSTI.

DAVIS-BESSE POWER REACTOR—electrical systems for, preliminary safety analysis of
—emergency and auxiliary systems for, preliminary safety analysis of
—steam and power conversion system for, preliminary safety analysis of
—radiation protection and radioactive waste processing at, preliminary safety analysis of
—operation of, preliminary safety analysis of proposed
—safety analyses for, preliminary
—Technical Specifications for, preliminary proposed (M.L.S.)

43051 (TID-25155) REPORT TO THE ATOMIC ENERGY COMMISSION ON THE REACTOR LICENSING PROGRAM. (Division of Reactor Licensing (AEC), Washington, D. C.). June 1969. 51p. Dep. CFSTI.

The assessment of the reactor licensing process, as reviewed by the internal study group of the Division of Reactor Licensing, is presented. The study group reviewed the licensing process from its adequacy of protection of health and safety of the public and whether regulatory procedures and requirements have adversely affected the development of the nuclear industry. Recommendations for regulatory safety criteria are listed. The views of what constitute safety standards are considered and recommendations are made. A quantitative risk assessment is discussed; the relation of this concept to the present state of safety evaluations is discussed. Standardization of design, backfitting, the role of the ACRS, and timing and staging in the review and decision-making process are considered. (M.L.S.)

43052 (UJV-2166-R) INFLUENCE OF THE PARTLY DROPPED CONTROL ROD ON THE TEMPERATURE REGIME OF SURROUNDING FUEL ELEMENTS. Pfann, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1969. 33p. (In Czech). Dep.

The ALGOL computer code for the investigation of partly dropped control rod effects on fuel element temperature distributions is described. The program makes possible the calculation of the axial temperature distribution in fuel, cladding and coolant, and changed distribution of heat sources and coolant pressure. The effects of the control rod dropped in various depths in the active core at full and reduced coolant flow rate can be examined. The demand to regain the original maximum cladding temperature at lower heat power is the criterion for the flow rate reduction. The code is used for the Bohunice Power Reactor active core investigation. 14 references. (auth)

43053 CONSTRUCTION OF THE CONTAINMENT BUILDING FOR THE GENTILLY NUCLEAR POWER REACTOR. Amyot, Paul (Gentilly Nuclear Power Station, Quebec). Nucl. Eng. Design, 9: 479-87(Apr. 1969).

A brief description is given of the techniques and methods used for the construction of the prestressed concrete containment building for the Gentilly Nuclear Power Station. The containment building consists of a base slab, a circular wall, a ring beam and a dome. It has the shape of a cylinder measuring 120 feet interior diameter, topped by a spherical dome. The total height is 175 feet measured from the basement floor to the top of the dome. Leak-tightness is achieved by the use of an epoxy-vinyl lining applied on the interior surface of the containment. (auth)

43054 THE U. S. NUCLEAR ENERGY INDUSTRY 1967. Bull. Belgicatom, 13: 11-13(Jan.-Mar. 1968).

For the second consecutive year, nuclear power accounted for more than 50% of the new generating capacity ordered in the U. S. U. S. utilities placed orders for 31 nuclear units with a combined generating capacity of 25 million kW(e). The Atomic Energy Commission had predicted that nuclear generating capacity in 1980 would amount to 120 to 170 million kW. The 1967 orders were for plants not expected to begin operating until 1972 at the earliest. All of the big reactors ordered during the year were of the types cooled by boiling or pressurized water. (BBB)

43055 GENTILLY NUCLEAR POWER STATION (QUEBEC). Real-Boucher, G. Energ. Nucl. (Paris), 11: 134-43(May 1969). (In French).

The Canadian Gentilly nuclear power station is in an advanced state of construction and will be completed in 1971. The reactor deriving from the heavy-water moderated CANDU type will use natural water in a direct cycle as the coolant. The reactor is oriented vertically with on-power fuelling by a single fuelling machine located below the reactor. Particular precautions are taken to overcome stability problems and to minimize the consequences of hypothetical accidents. Digital online control computers will enhance safety and provide for increased flexibility of operation. (auth)

43056 AT THE FRENCH NUCLEAR POWER STATION OF SAINT-LAURENT-DES-EAUX, AN APPLICATION OF NUMERICAL COMPUTERS WHICH PRESAGES THE FUTURE. Benmergui, A.; Dive, P. Automatisme, 14: 91-8(Mar. 1969). (In French).

Control-command installations in French nuclear power stations are discussed. Economic aspects pointed to a computerized installation at the EDF 4 station. The organization of various parts of the automated system of EDF 4 are noted. Sequential automation of starting and stopping includes preliminary verifications, arrangement of starting operations, and a final test of good execution. Automation of failure treatment are classified into failures of an analog type and failure of a binary type. Regulation of the plant is also automated. Typical regulation problems are the CO_2 in the reactor and spatial regulation of neutron flux. Experience acquired in service is outlined. Choice of computers for regulation is discussed. (BBB)

43057 A ZRA 1 PROGRAM FOR THE MONTE-CARLO CALCULATION OF SYSTEM RELIABILITIES. Prochnow, D. (VEB Kernkraftwerksbau, Berlin). Kernenergie, 12: 127-31(Apr. 1969). (In German).

In general, the requirements of reliability made with respect to the safety of nuclear plant systems are very high. The theoretical foundations of a reliability study carried out in connection with the plant system "total failure of voltage" for Rheinsberg nuclear power plant were studied. The study was based on the Monte-Carlo methods of theory of probability. A ZRA 1 programme has been established as the result of this study which allows evaluating the output and system reliabilities within statistically secured limits to tolerance for an acyclic system interconnected in an arbitrary manner. The reliability scheme and the failure rate per unit time for each component must be known for applying the programme. 14 references. (auth)

43058 REMOTELY CONTROLLED AND SUPERVISED WORK WITHIN A REACTOR PRESSURE VESSEL. Vowles, A. F. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc., 8: 189-96(July 1969).

Investigation, following difficulty in picking up fuel elements in the channel of a Bradwell reactor during on-load refueling, revealed that nuts and bolts were missing from two steel support assemblies attached to the base of the standpipe nozzles in the center of the top dome of the pressure vessel. Remote unbolting, dismantling, and removal of these two structures, each 800 lb wt and 5 ft by 3 ft dia, from the reactor during shutdown are described. A brief account is given of the preparation for start up. (UK)

43059 LOCATION AND REPAIR OF A LEAK IN THE DOUNREAY FAST REACTOR PRIMARY CIRCUIT. Matthews, R. R.; Henry, K. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). J. Brit. Nucl. Energy Soc., 8: 168-77(July 1969).

The NaK leak was detected by a spark plug type detector. Methods of locating the leak included monitoring the leak jacket for coolant and for pressurized blanket gas, the use of Au tracer, and bubble noise measurements on pressurized leak jackets. A crack was found in the area of a site weld on removal of a suspect 10 ft length of 4 in. dia pipe from outside the neutron shield. Developments in cutting and welding techniques used in removal and repair of the faulty section are described. (UK)

43060 SAINT LAURENT-DES-EAUX. Nucl. Eng. Int., 14: 635-40(Aug. 1969).

The design of the 500 MW(e) nuclear power station, St. Laurent I, is briefly described. A folded chart gives a cut-away view of the reactor and lists the main parameters. The major contractors are also listed. Improvements being incorporated in the second unit, St. Laurent II, will give it a gain in power of 6%. (UK)

43061 VENTILATION FOR HIGH TEMPERATURE HELIUM GAS COOLED NUCLEAR REACTOR. Stevenson, F. F. Heat., Piping Air Cond., 40: No. 10, 136-7(Oct. 1968).

The ventilation facilities for the Peach Bottom Power Reactor Unit 1 containment system are described. (auth)

43062 NINE SUITABLE SITES FOR NUCLEAR REACTORS BETWEEN VALDEMARSVIK AND OESTHAMMAR. Norhammar, Ulf (Svenska Teknologfoereningen, Stockholm). Tek. Tidskr., 99: 507-10(1969). (In Swedish).

A study made by the Swedish State Power Board on suitable sites for nuclear power reactors on the coast of the Baltic Sea is reviewed. (Sweden)

43063 GAS-COOLED REACTOR WILL USE CONCRETE VESSEL. Walker, R. F. (Public Service Co. of Colorado, Denver); Johnston, T. A. Elec. World., 170: No. 10, 27-30 (Sept. 1, 1968).

Design parameters for the Fort St. Vrain Power Reactor Unit 1 are presented. A description of the prestressed concrete pressure vessel is included. (auth)

43064 PUBLIC HEALTH FACTORS IN REACTOR SITE SELECTION. Terrill, J. G. Jr.; Weaver, C. L.; Harward, E. D.; Smith, J. M. (Public Health Service, Rockville, Md.). J. Sanit. Eng. Div., Amer. Soc. Civil Eng., 95: 545-61(June 1969).

Factors involved in construction of nuclear power stations in, or near, populated communities are considered; environmental surveillance programs are outlined. Field studies carried out through the U. S. Public Health Service regional laboratories to provide basic data needed to determine surveillance requirements and develop optimum techniques for use by State agencies and facility operators are described. Emphasis is placed on identifying critical pathways of population exposure, including reconcentration factors, or indicator nuclides to monitor these, and on the relation between stack discharges and the associated environmental levels produced. Compilations of reported data from all operating power reactors are discussed. An automatic data processing system for retrieval of information that will be of use to State and local health agencies, other Federal agencies, and the nuclear industry is described. Reactor liability insurance is discussed. (TSS)

43065 THE ON-LINE SYSTEM OF COMPUTERS FOR THE ELECTRONUCLEAR POWER STATION OF HINKLEY POINT B. Smith, W. (English Electric Co. Ltd., Kidsgrove, Eng.). Elettrotechnica, 56: 172-5(Mar. 1969). (In Italian).

The computer which handles each of the 2 reactor-turbine-alternator units at the Hinkley Point B nuclear power station is described. The data acquisition system is described, and details of real time functioning of the program are given. The language used is "Plant Autocode." (TSS)

43066 TO KIKET OR TO KICK IT? Morris, Bill. Queen City Mag., 1: No. 6, 26-34(June 1969).

The common sense approach to the proposed siting of a nuclear power plant in Puget Sound is given in layman's language. Factors, both for and against, the power plant site are considered. Seattle's power requirements are considered; environmental factors are discussed. (M.L.S.)

43067 CIRCULATION PUMPS OF THE PRIMARY CIRCUIT FOR LARGE NUCLEAR POWER PLANTS. Goldanich, Giuliano. Termotecnica (Milan), 23: 179-87; 192(Apr. 1969). (In Italian).

The tendency in the design of nuclear power stations is characterized by the trend toward increase in block capacities, especially owing to economical considerations. The bigger the plant, the more importance is attached to the main components. In this connection, the main circulating pumps of the reactor are of particular interest, since they are the only rotary machines directly connected with the reactor. A brief outline of the development of these machines is given, and details are stated as to the different duties which the various reactor types impose upon the circulating pumps. It becomes evident that, due to the various reactor systems, different solutions have to be provided. Based on some examples, a description of machines already built is given. The type of bearings and the method of shaft sealing are dealt with. (auth)

43068 OCONEE NUCLEAR STATION TO COST $100 PER NET KW. Lee, W. S. (Duke Power Co., Charlotte, N. C.). Elec. World., 169: No. 16, 27-9, 70(Apr. 14, 1968).

Cost analysis for the Oconee Power Reactor Unit 1 is presented. Design parameters are described. The construction schedule is presented. (D.C.C.)

43069 NUCLEAR UNIT WILL HAVE REMOTE DISPATCH. Kincaid, W. B. (Carolina Power and Light Co., Raleigh, N. C.). Elec. World., 170: 28-9(Aug. 19, 1968).

Design parameters for the H. B. Robinson Power Reactor Unit 2 are presented. Site preparation is described. (D.C.C.)

43070 REACTOR PRESSURE VESSEL GETS FIELD ASSEMBLY. Jensen, R. J. (Northern States Power Co., Minneapolis); Parkinson, G. L.; Webb, R. S.; Violette, J. B. Elec. World., 170: No. 11, 27-9(Sept. 9, 1968).

The field assembly techniques for the 472 MW(e) Monticello Power Reactor pressure vessel are described. (D.C.C.)

43071 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety, 10: 466-80(Sept.-Oct. 1969).

Regulatory action and review is summarized for the following reactors: Brunswick 1 and 2 (Dockets 50-324 and 50-325), Calvert Cliffs 1 and 2 (Dockets 50-317 and 50-318), Enrico Fermi 2 (Docket 50-341), Robert E. Guina (Docket 50-244), Edwin I. Hatch (Docket 50-321), Indian Point 3 (Docket 50-286), Midland 1 and 2 (Dockets 50-329 and 50-330), Nine Mile Point (Docket 50-220), North Anna 1 and 2 (Dockets 50-338 and 50-339), Oyster Creek (Docket 50-219), and Seabrook (Docket 50-340). (M.L.S.)

43072 A SHIFT SUPERVISOR'S INTRODUCTION TO PRACTICAL LOCAL METEOROLOGY. Swisher, Searle D. (Environmental Science Services Administration, Washington, D. C.). Nucl. Safety, 10: 431-6(Sept.-Oct. 1969).

The role of meteorology during the routine operation of a nuclear reactor has not been well documented, although the meteorology of the site is given in the safety-analysis report. Meteorological training of the reactor staff is available through the use of recent compilations of literature on atmospheric diffusion and courses given by the National Air Pollution Control Administration. A simple method exists for estimating, with the use of graphic overlays, the ground-level concentrations and dosages for use in determining action to be taken following air releases during emergency and routine situations. Although various special meteorological conditions limit the accuracy of the technique, these limitations may be accommodated. 21 references. (auth)

43073 TRAINING NUCLEAR POWER-PLANT OPERATORS WITH COMPUTERIZED SIMULATORS. Bates, A. E. G. Nucl. Safety, 10: 405-11(Sept.-Oct. 1969).

A number of different methods of training operators to handle the controls of nuclear steam-supply systems have produced personnel who satisfactorily meet AEC licensing requirements. The need for original and refresher training of operators is increasing rapidly, and it appears that existing facilities will require augmentation in the near future, especially if some of the smaller nuclear power plants presently used for this training are shut down. Elaborate training simulators are available which duplicate the control-room arrangements and hardware of the actual plants and include computers to simulate the characteristics of the nuclear steam-supply system and turbine. Such simulators, although expensive, make satisfactory operator-training devices, and their use can be expanded to handle any foreseeable training loads. 35 references. (auth)

43074 POTENTIAL METAL-WATER REACTIONS IN LIGHT-WATER-COOLED POWER REACTORS. McLain, Howard A. Nucl. Safety, 10: 392-404(Sept.-Oct. 1969).

The available data on the role of chemical reactions in the unlikely event of a light-water-cooled power-reactor accident were collated and studied. Chemical reactions are only one aspect of the reactor accident, and, compared with the other aspects, the basic kinetics of the chemical reactions are well understood. Use of the engineered safety features in nuclear power plants would limit the extent of any metal-water reaction in a design-basis accident to a negligible value. However, for the degenerate cases where the engineered safety features do not operate properly when required, there are some unknowns about the exact role of metal-water reactions. Also, there is considerable evidence that Zircaloy cladding becomes very brittle and tends to fragment if sufficient oxygen from the steam reacts with the metal or dissolves in it. 55 references. (auth)

43075 GERMAN PRACTICES WITH RESPECT TO REACTOR SITING. Ergen, William K. Nucl. Safety, 10: 377-9 (Sept.-Oct. 1969).

German policies with respect to reactor siting are similar to those in the United States. Where differences in philosophy exist, the Germans are somewhat more liberal. This is to be expected, since Germany has fewer alternatives to placing reactors in populated areas. As a practical matter, however, the German sites used so far are not more populated than some approved American sites. 9 references. (auth)

43076 A COMPARISON OF CANADIAN AND U. S. SITING POLICIES. Hake, G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Safety, 10: 365-72(Sept.-Oct. 1969). (AECL-3156).

The siting conditions that apply to the Canadian Pickering and the U. S. Indian Point 2 and Oyster Creek stations were analyzed in a general way to show that in both countries the approval of these stations has involved three similar conditions: a fifth-order reduction in the total risk, credit for active components of the containment system equivalent to a first- or second-order reduction of risk, and integrated population doses of about 10^6 Rems to the thyroid. It is suggested that a requirement based on a population dose limit is likely to be more easily accommodated than a requirement based on a population distance limit. It is also suggested that, in the practical siting situations likely to arise, the individual dose at the exclusion boundary will govern, and the population center distance criteria as presently defined in the U. S. regulations are therefore unnecessarily restrictive. 17 references. (auth)

43077 LA CROSSE BOILING WATER REACTOR PROJECT. HEARING BEFORE THE SUBCOMMITTEE ON LEGISLATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST SESSION ON LA CROSSE BOILING WATER REACTOR PROJECT AND MATERIALS CONCERNING HALLAM, ELK RIVER, PATHFINDER, BONUS, AND PIQUA REACTOR PROJECTS, MAY 4, 1967. Washington, D. C., Joint Committee on Atomic Energy, 1969. 541p. GPO $2.25.

Power Reactor Development

Refer also to abstracts 40920, 40959, 41542, 43181, and 43183–43185.

43078 (CONF-670338, pp 185-96) PROSPECTS AND PROBLEMS OF NUCLEAR POWER IN CHILE. Friedmann, Efrain (Comision Chilena de Energia Nuclear, Santiago).

The situations in the northern desert and in the central part of Chile are discussed separately. For the northern region the expected demands of electricity and water for the next 20 years are described and the different ways in which they could be supplied are compared. The conditions under which a nuclear dual-purpose plant with a power of 50 to 80 MW(e) and water production of 30,000 m^3/day might be an economic and feasible solution within the next 6–7 years are discussed. For the central region, the results of studies using linear programming techniques indicate that the optimum electrical supply system requires the installation of thermal plants by 1975–1980. These could be nuclear, as they will be used as base load installations and are sufficiently large in size (about 300 MW(e)). In both cases some of the problems to be faced are discussed—problems such as lack of engineering experience, foreign currency, contents of plants and fuel, high internal rates of interest, and different local construction costs. (auth)

43079 (CONF-670338, pp 197-214) HIGH TEMPERATURE, GAS-COOLED ADVANCED CONVERTER REACTORS. Dahlberg, Richard C. (Gulf General Atomic, Inc., San Diego, Calif.).

Characteristics of high temperature gas cooled reactors being designed and developed are summarized with emphasis on the Peach Bottom and Fort St. Vrain reactors. The core configurations, fuel zone arrangement, cooling system, and fuel management schemes are described. Fuel cycle cost data are presented for HTGR concepts of various sizes. (H.D.R.)

43080 (CONF-670338, pp 215-28) BRAZILIAN ADVANCED THORIUM CONVERTER. de Salvo Brito, Sergio (Comissao Nacional de Energia Nuclear do Brasil, Rio de Janeiro).

In September 1965, the CNEN requested the Institute of Radioactive Research to prepare a preliminary study of the feasibility of a heavy water and thorium reactor. The project is being developed with the cooperation of the French "Commission de Energie Atomique." The work done by the Thorium Group of the IPR during 1966 is described. A brief description of the project, as well as the preliminary results of economic studies relative to different fuel cycles (U-235-Th or Pu-Th), is presented. (auth)

43081 (CONF-670338, pp 251-5) INTERAMERICAN DEVELOPMENT BANK AND ELECTRIC POWER FINANCING IN LATIN AMERICA. Salazar, Eugenio (Inter-American Development Bank, Washington, D. C.).

The InterAmerican Development Bank has been active in financing electric power development projects in Latin America since 1961. The Bank has resources of about 2.5 billion dollars, and through February 1967, it has made 402 loans with an estimated value of approximately 2 billion dollars. Twenty-six loans for electric power projects have been made to nine countries for a total of 176 million dollars. The largest investments are in Brazil, and form part of the Parana river hydroelectric developments. Substantial loans have also been made for the expansion of the Paulo Afonso hydroelectric plant in northeast Brazil. It is estimated that 27,000 MW(e) of installed capacity must be added in Latin America during the decade 1966–1975. This additional capacity will require an investment on the order of 11 billion dollars, of which 4 billion must be in foreign currencies. Thus the Bank and other international financial institutions must anticipate investing about 3 billion dollars in the electrical energy sector during 1966–1975. (auth)

43082 (GA-8471) A TECHNICAL DESCRIPTION OF STUDY "A": A BASE CASE DESIGN OF ON-LINE REFUELING MACHINE FOR A MULTIPLE REACTOR HTGR POWER STATION. Paget, J. A. (Gulf General Atomic, Inc., San Diego, Calif.). June 30, 1968. Contract AT(04-3)-167. 83p. Dep. CFSTI.

The objective of study "A" was to create a simple, rugged refueling machine for a nuclear power plant consisting of two 1000 Mw(e) high-temperature gas-cooled reactors. The reactors are arranged side by side so the single machine passes through the space between steam generator penetrations as it moves between reactors. The machine has a prestressed concrete vessel for both shielding and pressure containment, a bridge and trolley system for mobility, and a semiautomatic positioning system. The preliminary design was carried to the point where cost and performance can be reliably estimated. Component design was developed to the point where characteristics and feasibility are apparent. The study "A" design and the reasoning behind the principal design features are described. (H.D.R.)

43083 (GA-9227) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending February 28, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 28, 1969. Contract AT(04-3)-167. 141p. Dep. CFSTI.

BLOWERS—design criteria for reheat steam-driven helium, for 1000 MW(e) HTGR concept
FISSION PRODUCTS—behavior in HTGR systems, (T)
  —sorption by graphite, (E)
  —diffusion in graphite, (E)
GRAPHITE—fission product diffusion in, (E)
  —sorptive properties for fission products, (E)
REACTOR FUELS—reprocessing methods for HTGR type, (E/T)
  —development of coated particle, for HTGR type reactors, (E)
REACTORS, GAS COOLED—design parameters for 1000 MW(e) HTGR concept, development during Dec. 1968–Feb. 1969
  —fission product behavior in HTGR systems, (T)
  —fuel recycle in HTGR type, reprocessing methods for, (E/T)
  —physics of HTGR type, (E/T)
  —fuel cycle for HTGR type, evaluation of low enrichment uranium, (E/T)
  —fuels for HTGR type, development of coated particle, (E)
  —coolant circulator for 1000 MW(e) HTGR concept, design criteria for reheat steam-driven helium
  —structures and foundations for 1000 MW(e) HTGR concept, design criteria for (H.D.R.)

43084 (GEAP-5769) RESEARCH AND DEVELOPMENT REQUIREMENTS FOR A 1000 MWe SODIUM-COOLED FAST REACTOR. TASK IV REPORT OF 1000 MWe LMFBR FOLLOW-ON WORK. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr. 1969. Contract 31-109-38-1997. 230p. Dep. CFSTI.

For Argonne National Lab., Ill.

The new data, information, and research and development programs required for the successful design, construction, and startup of the reference concept 1000 MW(e) LMFBR by 1980 are defined. (H.D.R.)

43085 (ORNL-TM-2604) REFERENCE STATE-OF-THE-ART DESIGN AND TECHNOLOGICAL ASSESSMENT OF A 1500-kw(e) PRESSURIZED-WATER REACTOR. Samuels, G.; Lackey, M. E. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 418p. Dep. CFSTI.

A pressurized-water plant for producing 1500 kW of electricity and 2500 kW of export heat is described. This conceptual design is based on the current state of the art. The plant has a thermal output of 11,750 kW and is assumed to be the prime source of power for a remote land-based installation. It rejects waste heat to the atmosphere from air-cooled condensers. The reactor core consists of a single assembly containing 1702 Zircaloy-clad UO_2 fuel elements, 102 Zircaloy-clad B_4C–Zircaloy poison elements, and 120 stainless steel-clad Ag–In–Cd control rods. The control rods are grouped into six assemblies composed of 20 absorber rods each. The core is designed for a minimum life of 50 MWyr. 276 references. (auth)

43086 (TID-8200(20th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF JUNE 30, 1969. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 34p. Dep. CFSTI.

A complete revised listing is presented for all reactors in the U.S. and all reactors manufactured by U.S. companies which have been exported. The name of the reactor is listed with location, principal nuclear contractor, type of reactor, power, and startup date. Reactors are organized by: civilian reactors, production reactors, military reactors, and reactors for export. (D.C.C.)

43087 (WASH-1088) AN EVALUATION OF STEAM-COOLED FAST BREEDER REACTORS. (Oak Ridge National Lab., Tenn.). Apr. 1969., 360p. Dep. CFSTI.

The technical status and economic potential of three steam-cooled fast breeder reactor concepts that have inlet steam pressures of 1250, 2680, and 3700 psi are evaluated. The evaluation follows a set of specified ground rules, and all concepts are reviewed and analyzed on the basis of data on physics, thermal-hydraulic analysis, fabrication and engineering practices, and cost data. attempts were made to incorporate equivalent engineered safeguards in all three concepts. It is concluded that no major technological breakthroughs would be required to solve the problems of constructing a successful and economic steam-cooled fast reactor. Breeding ratios of from 1.0 to 1.4 can be attained. (H.D.R.)

43088 ROLE OF FAST BREEDER REACTORS IN NUCLEAR POWER PROGRAM. Leipunskii, A. I. (Physical-Energetics Inst., Obninsk, USSR). Kernenergie, 12: 109-11(Apr. 1969). (In German).

The role of the fast breeder reactor in the production of electricity is discussed. Fuel requirements and breeding potential for various converter reactors are listed. The objectives of the fast breeder program are outlined. (M.L.S.)

43089 SOME IMPLICATIONS OF THE FAST REACTOR PROGRAM IN THE U. S. Bull. Belgicatom, 12: 11-12(1967).

Of the total orders placed for power generators in 1966, almost 40% were for nuclear units, and of the announcements of new plants, about 55% were nuclear. The investment required to bring into existence a viable breeder reactor capability having confident support will be at least 2 billion dollars. It is proposed that the AEC should finance the development, and encourage the building by industry, of one or more advanced converters. The power industry cannot afford to jeopardize any of its principal networks by a major loss of generating capability over an extended period. Breeder reactor designs have not yet proven their worthiness in power applications. The present approach to this problem is to sponsor and encourage alternate technologies. The major problem is assuring a long-term future for a viable, competitive, free-enterprise industry in atomic power generation. In our society, the industry itself cannot tolerate a situation tending toward monopoly. An encouraging precedent exists in the light water reactor field, in which part of the industry adopted the boiling water, and the other part the pressurized water technology, with either one able to make a later transition to the other. (BBB)

43090 NUCLEAR POWER IN THE U. S. A.: 1968. Bull. Beglicatom, 14: No. 1, 10-11(May-June 1969).

A review of developments in the nuclear industry in the U. S. during 1968 is presented. (auth)

43091 THE STATE OF DOMESTIC DEVELOPMENT OF ADVANCED THERMAL REACTOR. Sawai, Sadamu (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nippon Kikai Gakkaishi, 72: 490-7(Apr. 1969). (In Japanese).

The development of the Advanced Thermal Reactor and Fast Breeder Reactor in Japan is described. The ATR was determined to be D_2O moderated and boiling light-water cooled. In October 1967, the Power Reactor and Nuclear Fuel Development Corporation was established to serve as the nucleus in the development of both ATR and FBR; at present, development efforts are being organized. Some features of the development of ATR are as follows: there is the possibility in the future of competing with the conventional reactors in economy; the efficient use of nuclear fuels is possible; and the versatile utilization of fuel materials is enabled, being operable even with natural uranium. The main specifications of the ATR are as follows: heat output 515 MW and electric output 165 MW; slightly enriched uranium in pellets; and shim and regulating rods of stainless steel plus B_4C. Construction of the prototype will be started in 1970, going critical in 1974; the completion of the full-fledged ATR is scheduled for about 1977. (NSA of Japan)

43092 IN-CORE THERMIONIC REACTOR (ITR). Gross, F. (Brown, Boveri, and Cie. AG, Mannheim, Ger.); Langpape, R.; Einfeld, K.; Schoen, Th.; Budnick, D.; Janner, K. Kerntechnik, 11: 381-9(July 1969). (In German and English).

A contemplated experimental prototype of an in-core thermionic reactor is described. The reactor will contain 19 thermionic fuel rods, each with seven converter cells connected electrically in series, and about 400 driver fuel rods required to make the system critical. The coolant will be Na, the moderator will be YH for the thermionic fuel rods, and yttrium hydride or ZrH for the driver rods. The contemplated electric power output is 20 kW, and the specific mass corresponding to this output, including radiators, is expected to be around 60 kg/kW. It is anticipated that both these values can be substantially improved as development work progresses. 8 references. (auth)

43093 SEFOR READY SOON FOR FAST BREEDER EXPERIMENTS. Holmes, Harlan T. (Arkansas Power and Light Co., Little Rock). Elec. World., 169: No. 20, 32-3(May 13, 1968).

The design parameters for the Southwest Experimental Fast Oxide Reactor are described. The planned operational schedule is presented. (D.C.C.)

Kinetics and Dynamics

43094 (AI-AEC-12847) INTERIM DESCRIPTION OF A COMPUTER PROGRAM (STP-1) FOR ESTIMATING THE DISTRIBUTION OF FISSION AND CORROSION PRODUCT RADIOACTIVITY IN A LIQUID METAL-COOLED FAST BREEDER REACTOR. Zwetzig, G. B.; Rose, P. F. (Atomics International, Canoga Park, Calif.). June 29, 1969. Contract AT(04-3)-701. 41p. Dep. CFSTI.

The theory and interim status of the Source Term Computer Program (STP-1, Version 2) are described. This program is designed to compute the distribution in a liquid metal-cooled fast breeder reactor of radioactivity both from fission product leakage from the fuel and from activation and corrosion of primary loop structural materials. The program accounts for this distribution between the fuel, cladding gas space, coolant, primary loop surfaces, cold traps, and cover gas. The program is now operational for a range of input parameters, though the integration scheme is not yet sufficiently stable to follow severe transients or to follow very short-lived fission product behavior. (auth)

43095 (INR-1032) DYNAMICS MODEL FOR LARGE POWER REACTOR. Rafalska, Joanna (Institute of Nuclear Research, Warsaw (Poland)). 1969. 24p. Dep.

A dynamics model for a large power reactor is proposed. The reactor was treated as the system of coupled subreactors. For derivation of the diffusion equations a nodal approach was used. The reactor has been presented in the form of V-structure system. The internal reactivity feedbacks have been taken into account. 6 references. (auth)

43096 (KR-135) RAMONA I: A FORTRAN CODE FOR TRANSIENT ANALYSIS OF BOILING WATER REACTORS AND BOILING LOOPS. Bakstad, P.; Solberg, K. O. (Institutt for Atomenergi, Kjeller (Norway)). Nov. 1968. 52p. Dep.

A boiling water reactor dynamics code RAMONA I is described. The digital computer program and some modifications and improvements in the model are described. The code calculates the space-time behavior of a boiling water reactor or an electrically heated loop for several disturbances which may be chosen by the user. By numerical Laplace transform, transfer functions may be calculated to facilitate frequency domain studies. A detailed description of the code, input and output, and sample calculations are included. The program is coded in 3600 FORTRAN for a CDC-3600 computer. 11 references. (auth)

43097 (WCAP-3680-21) CONTROL PROCEDURES FOR XENON-INDUCED X-Y INSTABILITIES IN LARGE PRESSURIZED WATER REACTORS. Skogen, Finn B.; McFarlane, Allan F. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). Feb. 1969. Contract AT(30-1)-3680. 51p. (EURAEC-2111). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

Using digital simulation techniques, various methods were investigated for the control of Xe-induced spatial oscillations in large, pressurized water reactor (PWR) cores. The oscillations are studied in a three-zone core, eleven feet in diameter, in a plane at right angles to the coolant flow. It is shown that successful control can be achieved by a single insertion of one appropriate rod selected from a number of suitably located control rods. The effect of varying the duration and position of rod insertion is discussed, and various alternate control procedures are proposed and evaluated. 3 references. (auth)

43098 (ZJE-50) THE MODIFICATIONS OF INTEGRAL TRANSPORT THEORY FOR FLUX CALCULATION IN HWGCR LATTICE CELL. Lehmann, Miroslav (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant). Mar. 1969. 24p. Dep.

Specific modifications of integral transport method are analyzed: application of diffusion approximation of neutron flux in moderator and method of cluster fuel element homogenization. The influence of introduced simplifications on precision of solution is determined by comparison with results of more accurate methods. 6 references. (auth)

43099 KINETICS OF THE STEAM COOLED FAST REACTOR. Takahashi, Ryoichi; Saito, Takashi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 83, 75-85(Mar. 1968).

The kinetic behavior of the steam cooled FBR and the effect of Loeffler boiler on the behavior were analyzed using the transfer function technique. Formulating transfer functions of the system, the corresponding steam cooled FBR to the reactor designed at Karlsruhe was examined. The time constant of Doppler effect affects seriously the transient when the coolant dynamics is sensitive to the power level deviation. In the response to the loss of flow, there was no extreme power rising and only the slow increase of the coolant temperature was seen, which produced the build-up of the reactivity. This behavior indicates that the artificial control is possible. In the response to the pressure change, the flushing of Loeffler boiler due to the pressure drop stabilizes the core, and the induced increment of saturated steam in the boiler occurs. It was concluded that in the steam cooled FBR the coolant temperature is much influenced by autocatalytic properties due to the relation between heat capacity and temperature, and Loeffler boiler can be regarded as the stabilizer. (NSA of Japan)

43100 LIFETIME CONSIDERATION AND ECONOMIC EVALUATION OF A LARGE, FAST, BREEDER, MIXED FUEL CYCLE SYSTEM. Green, Ivan Dale. Lafayette, Ind., Purdue Univ., 1968. 253p.

Thesis.

A major safety consideration in the design of large, fast, breeder, Na cooled reactors is the positive Na void coefficient. In order to obtain small Na void coefficients, recent designs have been based on high leakage cores resulting in significant compromises on the overall performance. Other designs based on hybrid or mixed fuel cycles have reduced Na void coefficients while maintaining near optimum configurations and appear to have only minimally reduced nuclear performance relative to all plutonium fueled systems. The effect of fuel depletion in conjunction with the Na void coefficient is analyzed. An economic evaluation of a particular mixed fuel cycle design is presented. In order to make a meaningful investigation and economic evaluation, a similar all plutonium reference fuel cycle design was chosen, and its lifetime and economic effects, calculated using identical methods, were compared to the mixed fuel cycle design. Results are presented. (Diss. Abstr.)

Control Systems

Refer also to abstract 40980.

43101 THE ANALYSIS OF NONLINEAR CONTROL OF NUCLEAR REACTOR DISTURBED BY RANDOM NOISE WITH THE AID OF THE QUASI-FUNCTIONAL METHOD. Bremsak, F. (Nuclear Inst. Josef Stefan, Ljubljana, Yugoslavia); Gyergyek, L.; Oblak, P. pp 286-98 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24-29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968.

See CONF-680642.

The existing methods of analysis of nonlinear systems with random inputs, i.e., quasi-linear, quasi-functional and direct differential equation method, can be applied to specific problem with more or less limited success. Quasi-linear methods involve the least mathematical difficulties and are well adapted for design use, but the accuracy is limited. Functional and direct methods are capable of yielding more exact solutions but are more difficult to apply. The direct method may only be used for a very restricted class of problems. The functional method is applicable, but only to weakly nonlinear systems. The quasi-functional representation of nonlinear controls with random noise as input is used and some applications of that method on relay type of nonlinearity and reactor transfer function approximations are presented and analyzed. (auth)

43102 DEVICE FOR SEALING THE CONTROL-ELEMENT GUIDE TUBE TO PREVENT COOLANT-WATER LEAKAGE. Sugaya, Junichi (to Hitachi Ltd.). Japanese Patent 1969-10796. May 1, 1969. Filed Mar. 4, 1966.

In certain types of nuclear reactors, upright fuel rods are set on the grid plate in the pressure vessel; a control rod is inserted into the arrangement of fuel rods from the vessel bottom through its guide tube. By the device proposed, when the control-rod drive just below the control rod is detached, the leakage of radioactive coolant water in the vessel can be stopped completely. The operation of its detachment is also simple and rapid. A control rod and the drive rod, etc., moves up and down through a guide tube, which penetrates the pressure-vessel bottom and extends to the grid plate. Before detaching the drive mechanism in the guide tube, a piston is placed in the guide tube at the position of pressure-vessel bottom. Around the circumference of this piston, piston rings are embedded onto the surface, to close the narrow space between the piston and the inside surface of the guide tube. The downward leakage of radioactive water from within the pressure vessel is therefore completely stopped. (NSA of Japan)

43103 REACTIVITY BALANCE AS AN ANOMALY DETECTOR. Danforth, H. P. Nucl. Safety, 10: 411-14(Sept.-Oct. 1969).

There are several reactor-control-system problems that have not been adequately solved with the use of conventional instrumentation. These problems are exemplified by a history of erroneous signals and misinterpretation of correct information by reactor operators. An on-line reactivity balance, although not a panacea, will detect many anomalous conditions that might occur in a reactor system and may be especially useful for the detection of coolant-flow blockage. 16 references. (auth)

Shielding

43104 PRESSURIZED WATER REACTOR CONTAINMENT DESIGNS. van Amerongen, L. (Westinghouse Electric International Co., New York). Kerntechnik, 11: 379-81(July 1969).

The types of containment used for PWR nuclear steam supply systems, are described. The effect that containment has on the project schedule, plant layout and plant erection is analyzed. (auth)

Cooling Systems

Refer also to abstracts 40656 and 40838.

43105 (EURAEC-1966) STUDIES ON CYCLONES FOR STEAM SEPARATION IN BOILING-WATER REACTORS. Quarterly Report No. 8, October 1-December 31, 1967. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Jan. 17, 1968. Contract 083-66-1-TEED. 52p. (EUR-3775; AEG-E-31/E-894). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The further development of a steam separator, consisting of down-flow cyclones, for use in large direct-cycle boiling-water reactors is described for a 600 MWe boiling-water reactor. The experimental studies with air/water mixtures on the problem of the mixture distribution to cyclones in different positions with regard to the core are discussed. The most suitable is a guide-sheet arrangement in which each of the three concentric rows of cyclones has its own inlet channel. Each of the three concentric guide channels begins about 2 m above the reactor core and deflects the mixture in the downcomer space towards the cyclones. Experimental full-scale studies are carried out on the mixture distribution to the cyclones in the two inner rows, the flows of two parallel cyclones connected up to a mixture chamber in each case. Results are presented. (auth)

43106 (EURAEC-2029) STUDIES ON CYCLONES FOR STEAM SEPARATION IN BOILING-WATER REACTORS. Quarterly Report No. 9, January 1-March 31, 1968. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Apr. 17, 1968. Contract 083-66-1-TEED. 42p. Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

A test program for optimizing the dimensions of a single down-flow cyclone steam separator for a large boiling reactor is described. Variations in cyclone configuration for optimization include water outlet cross sections and separation pipe or steam outlet pipe diameters. Pressure drops and maximum air flow for sufficient separation are measured. (D.C.C.)

43107 INTEGRAL BOILING WATER-SUPERHEAT NUCLEAR REACTOR. Wadmark, Lars Olof Tor (to Aktiebolaget Atomenergi). U. S. Patent 3,454,467. Priority date Apr. 1, 1965, Sweden.

Condensation of steam on the interior walls of a superheater tube of a boiling water-superheat nuclear reactor is minimized by extending the superheater tube through the moderator vessel of the reactor while being enclosed within an auxiliary tube, the upper end of which is open and communicates with the water space above the moderator vessel and the lower end of which communicates with the water space below the moderator vessel. (Offic. Gaz.)

43108 GAS-COOLED NUCLEAR REACTOR. Fortescue, Peter (to Gulf General Atomic Inc.). U. S. Patent 3,461,034. Filed Sept. 6, 1966.

A gas-cooled nuclear reactor is described having a prestressed concrete reactor vessel defining an elongated chamber. The pressure vessel is divided into three interior compartments. A reactor core is disposed in the middle compartment, and steam generating equipment is positioned in each of the end compartments. An access port is provided in each of the end walls of the reactor to provide access to the end compartments. A biological shield is incorporated within the reactor to reduce radiation from the core in the end compartments. (Offic. Gaz.)

43109 NUCLEAR REACTOR. Hiratsuka, Yasumasa (to Hitachi Ltd.). Japanese Patent 1969-9958. May 9, 1969. Filed Aug. 18, 1965.

In certain types of nuclear reactors, the pressure vessel in which the reactor core is located is immersed in the pool water. Heat is generated by the fission, and the temperature of the vessel is increased. This heat is directly transferred to the pool water; then, accidents are likely to occur in many ways. In the method proposed, such accidents due to the increase in temperature of the pool water are eliminated. The reactor core is enclosed in a vessel. Cooling water is circulated through the volume of this vessel to cool the reactor core through external pipe in which a forced circulation pump is installed. The pressure vessel and the external pipe are together enclosed in an outer vessel with small space between them, forming actually a "double-wall." The space is evacuated to give a high vacuum. This entire body is placed in the pool water. The vacuum maintained in the double-walled space prevents the transmission of heat from the vessel and pipe to the pool water. When the vessel or the pipe ruptures accidentally and the high-temperature steam is released, the steam is condensed in the pool water. (NSA of Japan)

43110 IMPROVEMENTS IN OR RELATING TO NUCLEAR VAPOUR GENERATORS. (to Babcock and Wilcox Ltd.). British Patent 1,158,133. July 16, 1969. Filed Oct. 14, 1965.

Reference is made to the arrangement of steam generating elements in nuclear reactors of the integral type. The object of the system described is to provide a reactor with an optimum economic annular space containing the heat exchanging tubes. The boundaries of the annular space within the reactor pressure vessel are similar to and polygonal with corresponding sides of the pressure vessel walls. The annular space is occupied by groups of heat exchanger platens, the platens in each group having the same width. Various alternative arrangements are described. (UK)

43111 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Merrett, Dennis John (to United Power Co., Ltd.). British Patent 1,160,035. July 30, 1969. Filed Oct. 12, 1967.

Reference is made to reactors of the integral, gas-cooled, graphite-moderated type, with core housed in a "pressure bell." The reactor comprises a pressure vessel, an inverted cup-shaped biological shield within the pressure vessel, a graphite moderated core within the shield, and an inverted cup-shaped partition enclosing both shield and core with this partition being spaced from the pressure vessel by an annulus in which is located a series of vertical cylindrical heat exchangers. Means for circulating gaseous coolant through the core and heat exchangers are also included. The pressure vessel preferably has several access holes of circular cross-section, so as to permit removal of complete heat exchangers for maintenance or replacement. (UK)

43112 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Blumfield, Clifford William (to United Kingdom Atomic Energy Authority). British Patent 1,159,807. July 30, 1969. Filed Nov. 26, 1965.

Reference is made to reactors in which the fuel is in the form of pellets which, in operation of the reactor, are fluidized in the reactor core, the fluidizing medium serving also as the coolant. The fuel pellets are fluidized in a stream of an inert gas dust suspension, acting also as coolant, and the bed contains granules of moderating material which are circulated in heat exchange with the coolant. By suitable selection of pellet size and dust composition the coolant can serve as a lubricant or buffer between the fuel pellets. The dust suspension may be passed through the bed of pellets and circulated through heat exchangers or directed to a heat utilization plant. Particles of size intermediate between that of the dust and fuel pellets are fluidized to serve as moderator and adjust voidage. The particle sizes are such that should the fluidizing pressure be lost the core reactivity will automatically be reduced to a safe condition. By increasing the degree of fluidization reactivity loss due to burn-up can be made good. The fluidized bed may be confined to a central zone, leaving an annular passage for recirculation of the granules. The inert gas dust coolant may be passed through the annular space in counterflow to the granules. (UK)

43113 THERMODYNAMIC ANALYSIS OF NUCLEAR POWER STATION CYCLES WITH GAS-COOLED REACTORS. Haiduc, C.; Vidican, P. Rev. Roum. Sci. Tech., Ser. Electrotech. Energ., 13: No. 2, 327-40(1968).

A method has been developed for the thermodynamic analysis of nuclear power station cycles with gas-cooled reactors. The results obtained for six complex types of thermodynamic cycles and steam generator heat diagrams are presented and the prospects of heat cycles with steam superheating are illustrated. The method yields highly accurate results that can be used in the thermodynamic analysis and optimization of the parameters of nuclear power stations with GCR, HWGCR, AGR, and FBR reactors. (Rom. Sci. Abstr.) (auth)

Fuels

Refer also to abstracts 40851 and 41713.

43114 (GA-9359) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, February 1–April 30, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). June 12, 1969. Contract AT(04-3)-167. 53p. Dep. CFSTI.

PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation testing of gas cooled fast breeder fuels of
REACTOR FUEL ELEMENTS—cladding alloys for gas cooled fast breeder, development of vanadium base
—radiation testing of plutonium oxide (PuO_2)–uranium oxide (UO_2), for gas cooled fast breeder
REACTORS, BREEDER—core development for gas cooled, Feb.–Apr. 1969
REACTORS, FAST—core development for gas-cooled, Feb.–Apr. 1969
REACTORS, GAS COOLED—core development for fast breeder, Feb.–Apr. 1969
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation testing of gas cooled fast breeder fuels of
VANADIUM ALLOYS AND SYSTEMS—properties for cladding of gas cooled fast reactor fuel elements (H.D.R.)

43115 (GEAP-5753) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 29, November 1968–January 1969. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Feb. 1969. Contract AT(04-3)-189. 108p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during Nov. 1968–Jan. 1969
—core neutronics of
—thermal hydraulics of
—safety characteristics of
FISSION PRODUCTS—release from high performance mixed oxide fuel elements
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation testing of fuels of
—PuO_2-UO_2, physical properties of fuels of
REACTOR FUEL ELEMENTS—development of high performance mixed oxide, for Fast Ceramic Reactor
—cladding for mixed oxide, performance of defected
—cladding interface performance in contact with sodium
—fission product distribution and release from mixed oxide
—cladding alloys for fast reactor mixed oxide, performance characteristics of
—response of axially restrained mixed oxide, during severe transients
REACTOR FUELS—relocation of molten mixed oxide, during transients
—performance of mixed oxide, in fast reactors
REACTOR SAFETY—fuel element behavior during Fast Ceramic Reactor transients
STAINLESS STEEL—properties for use as fast reactor fuel cladding
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation testing of fuels of
—PuO_2-UO_2, physical properties of fuels of (H.D.R.)

43116 (GEAP-10028) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 30, February–April 1969. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). May 1969. Contract AT(04-3)-189. 137p. Dep. CFSTI.

FAST CERAMIC REACTOR—fuel elements for, development during Feb.–Apr. 1969
—core neutronics of

—thermal hydraulics of
—safety characteristics of
FISSION PRODUCTS—release from high performance mixed oxide fuel elements
PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, radiation testing of fuels of
—PuO_2-UO_2, physical properties of fuels of
REACTOR FUEL ELEMENTS—development of high performance mixed oxide, for Fast Ceramic Reactor
—cladding for mixed oxide, performance of defected
—cladding interface performance in contact with sodium
—fission product distribution and release from mixed oxide
—cladding alloys for fast reactor mixed oxide, performance characteristics of
—response of axially restrained mixed oxide, during severe transients
REACTOR FUELS—relocation of molten mixed oxide, during severe transients
—performance of mixed oxide, in fast reactors
REACTOR SAFETY—fuel element behavior during Fast Ceramic Reactor transients
STAINLESS STEEL—properties for use as fast reactor fuel cladding
URANIUM OXIDES UO_2—PuO_2-UO_2, radiation testing of fuels of
—PuO_2-UO_2, physical properties of fuels of (H.D.R.)

43117 (KFK-803) SAFEGUARDING FISSILE MATERIAL FLOW AT STRATEGIC POINTS IN POWER REACTORS. Gupta, D.; Eitz, A. W.; Haefele, W.; Keller, W.; Kornbichler, S.; Schabert, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb. 1969. 41p. (CONF-680961-1). Dep.

From Panel Meeting of the IAEA on Reactor Safeguards, Vienna, Austria.

If it can be ensured that the fuel pins or subassemblies remain intact inside the reactor and that only pins or subassemblies identified at the entrance of a reactor can be irradiated and discharged, only those measures required to ensure containment would be required to control the fissile material flow. It is also possible to establish a fissile material balance in a reactor, but present methods of analysis are inaccurate to the range of 5 to 15%. The possibility of safeguarding the fissile material in power reactors of the presently known types is evaluated. The analysis indicates present reactors are well suited for safeguards methods using mainly containment measures at various strategic points. (H.D.R.)

43118 (KFK-923) INVESTIGATION OF THE CHARACTERISTIC FREQUENCIES, THE NORMAL AND THE EXPANSION FUNCTIONS, AS WELL AS THE DAMPING OF THE TRANSVERSE VIBRATION OF FUEL RODS IN THE Na 1 STUDY. **Appelt, K. D.; Kadlec, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan. 1969. 41p. (In German). (EUR-3977). Dep.**

Calculations of the eigenfrequencies and associated eigen functions of the transverse vibrations of fuel rods for the Na-1 reactor studies are detailed. Effects of spacers and water and air media on the damping factors are analyzed; the calculations were made with the IBM 7094. 11 references. (M.L.S.)

43119 THE MAIN PRINCIPLES OF SELECTING THE CONTROL ELEMENTS FOR FAST POWER REACTORS. Orlov, V. V.; Matveev, V. I.; Zhukov, A. V.; Ivanov, A. P.; Pshakin, G. M. (Physical-Energetics Inst., Obninsk, USSR). Kernenergie, 12: 112-24(Apr. 1969). (In Russian).

Different methods of fast reactor control are considered. The calculated values of the efficiency of different materials for oxide-fueled reactors of different volumes are presented. It is shown that the most efficient control method for large fast reactors is the control with the use of absorbing materials. Different absorbing materials and the perspectives of their application for the fast reactor control elements are discussed. Some problems of the absorbing control elements effect on reactor physics are considered. A short review of the methods for designing the fast reactor control elements is given and the experimental and calculated values of control element efficiency are compared. The analysis of power and temperature effects in fast reactors with ceramic fuel is carried out. The components of these effects: core expansion, sodium effect and Doppler effect, are considered. Some methodological considerations on the calculation of these effects are presented. The values of these effects and their components for the reactor BN-350 and BOR are considered. 17 references. (auth)

43120 FUELS FOR NUCLEAR REACTORS. **Dippel, Theodor; Kummerer, Karl (Kernforschungszentrum, Karlsruhe, Ger.). Chem. Unserer Zeit, 2: 135-43(Oct. 1968). (In German).**

Fuels for reactors are compared, particularly Th, U, Pu, UO_2, PuO_2, UC, and PuC. Illustrations of the choice of a fuel for a particular situation, and the mode of constructing units from it, are given. Special consideration is devoted to the preparation of fuel in recent studies, particularly those on ceramic fuels and cermets. Specifications for fast breeder fuels (composition, stoichiometry, allowable impurities, homogeneity, tablet geometry for such fuel elements, tablet density, and allowable surface deviations) are discussed and representative data tabulated. Installation of such elements into a reactor and characteristics of the fuel cycle are outlined. Techniques for the preparation of breeder elements for the reactor are described briefly. (BBB)

43121 STATIC AEROELASTICITY OF GRIDS FOR NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. PART I. THEORY. **Kuzelka, Vaclav (National Research Inst. of Machines, Bechovice, Czech.). Jad. Energ., 15: 254-9(Aug. 1969). (In Czech).**

A method for the theoretical investigation of the static aeroelasticity of grids for gas-cooled nuclear reactor fuel element assemblies is developed. A general analysis is made and symbols from the point of view of aerodynamics are introduced. Solutions of problems are presented where the application of computers is assumed. The static effects of coolant aerodynamic forces are determined as a function of the stream characteristics. After the relations between acting forces and the strains have been expressed by influence coefficients, equations are derived in matrix forms for determining the critical parameters of the coolant gas stream at the stability limit of grids. 9 references. (auth)

43122 DETECTION OF FUEL ELEMENT SHEATHING FAILURES IN NUCLEAR REACTORS. **Webb, John; Gatley, John Andrew; McFall, Albert (to United Kingdom Atomic Energy Authority). U. S. Patent 3,453,867. Priority date Aug. 21, 1964, Great Britain.**

Apparatus for testing for fuel element sheathing failures in a liquid metal cooled fast nuclear reactor in which the core is immersed in a pool of the liquid metal coolant is described. The apparatus consists of means for localizing within a collector zone any gaseous substance derived from the fuel elements, and means for sensing whether the gaseous substance or coolant is mainly present in the collector zone. A sheathing failure can therefore be detected by interpreting the sensing means. The collector zone and sensing means are situated within the liquid metal coolant, which makes sampling pipes unnecessary. (Offic. Gaz.)

43123 METHOD OF PREDICTING THE RESPONSE OF AGR FUEL ELEMENTS TO ACOUSTIC NOISE. **Whitton, P. N. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc., 8: 207-12(July 1969).**

As part of the assessment of the integrity of AGR fuel element cladding, the possibility of lateral fuel pin vibration must be considered. It is demonstrated that the response to excitation by acoustic noise from the coolant gas circulators may be found using a statistical energy approach. The theory is illustrated by determination of the cladding stresses in a particular fuel element design. (auth)

Auxiliary and Emergency Systems

43124 NUCLEAR REACTOR INSTALLATIONS. **Ellinger, John Henry (to United Kingdom Atomic Energy Authority). British Patent 1,159,672. July 30, 1969. Filed May 3, 1965.**

Reference is made to means of absorbing heat released in the event of fracture of a water-cooled reactor pressure vessel or its associated coolant pressure circuit. In the system described the reactor containment is open at the bottom to a well; in the event of fracture of the pressure vessel or coolant circuit the initial shockwave of the resulting pressure surge of escaping coolant is absorbed in expelling water from the well, which is provided with shallow trays containing water or ice so that after some water has been expelled an extended surface of cooling medium is exposed in the path of further escaping coolant in order to remove heat therefrom. Some of the trays may be fitted with coolant pipes capable of freezing the contained water. (UK)

Operation and Economics

Refer also to abstract 43182.

43125 (HPR-109) HBWR QUARTERLY PROGRESS REPORT, JANUARY-MARCH 1969. **(Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). May 1969. 104p. Dep.**

The operating statistics of the Halden Boiling Water Reactor for the first quarter of 1969 are summarized. Fuel failures, plant modifications, and moderator chemistry are reported. Significant progress in the program of fuel irradiation, on-line digital computer control, development of in-core instrumentation, and water chemistry control is described. (H.D.R.)

43126 ECONOMIC ASPECTS OF BREEDING IN HEAVY WATER AND THORIUM REACTORS. Energ. Nucl. (Paris), 11: 176-8(May 1969). (In French).

Results of economic studies on the heavy water breeder reactor are summarized. Comparisons of various costs occurring in the fuel cycle are shown graphically. Fuel cycle costs for the CANDU-type breeder reactor are tabulated for Th−U, natural U, ^{233}U−Th, and enriched U−natural U; investment costs for these types of reactors are listed. (M.L.S.)

43127 REACTOR OPERATION. Shaw, J. Oxford, Pergamon Press, 1969. 269p.

The aspects of the design, physics, control, and instrumentation of reactors which are of importance in reactor operation are considered. Specific problems in the operation of gas-cooled graphite-moderated reactors are described in detail. (UK)

43128 DRAGON PROJECT, 1959–1969. Shepherd, L. R. Atom, No. 154: 215-36(Aug. 1969).

A review of the Dragon Project on the occasion of its 10th Anniversary is presented. Topics discussed include: HTR concepts; special problems of the HTGCR; developments leading up to the Dragon Project; work of the Dragon Project; present status of the HTR; future prospects; and lessons of the Project. (UK)

Safety and Siting

Refer also to abstract 41131.

43129 (APED–5696) TORNADO PROTECTION FOR THE SPENT FUEL STORAGE POOL. Miller, D. R.; Williams, W. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1968. 46p. Dep. CFSTI.

The potential effects of a tornado striking the fuel storage pool of a Boiling Water Reactor (BWR) are analyzed. A brief discussion of the tornado phenomena is provided and two key concerns are examined: whether sufficient water could be removed from the pool to prevent cooling of the fuel, and whether missiles could potentially enter the pool and damage the stored fuel. The design of the fuel pool makes the removal of more than five feet of water due to tornado action highly improbable. With 25 feet of water covering the fuel racks, the removal of five feet of water is of no concern. Protection against a wide spectrum of tornado-generated missiles is provided by the water which covers the fuel racks. It is shown that protection is provided against all tornado-generated missiles having a probability of hitting the pool greater than one per 1.4 billion reactor lifetimes. Typical potential missiles in this category include a spectrum ranging up to a 3-inch-diameter steel cylinder 7 feet long or a 14-inch-diameter wooden pole 12 feet long. 29 references. (auth)

43130 (BNWL–1084) NUCLEAR SAFETY QUARTERLY REPORT, FEBRUARY–APRIL 1969 FOR NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 142p. Dep. CFSTI.

ACOUSTIC EMISSION TESTING—pipe failure detection by, development of system for
AEROSOLS—transport to vertical surfaces by condensing steam, (T)
CALCINATION—spray equipment for radioactive waste solution solidification by, development of procedures for
CONTAINMENT SYSTEMS EXPERIMENT—spray system of, effectiveness for fission product aerosol removal of
—pressure suppression by water sprays in
—blowdown tests in, pressure and temperature transients during subcooled, (E/T)
—core support plate in, transient blowdown pressures on
FISSION PRODUCTS—removal from reactor containment, effectiveness of spray system for
GLASS—production of phosphate, for fixation of radioactive wastes
PIPES—crack detection in pressure, acoustic emission method for
RADIATION TARGET CANS—design for irradiation testing of reactor pressure vessel steels
RADIOACTIVE WASTE—fixation by conversion to phosphate glass, evaluation of test runs for
—solidification of solutions of, spray calciner development for
REACTOR SAFETY—containment spray system effectiveness for fission product aerosol removal and pressure suppression
—blowdown tests in CSE, pressure and temperature transients during subcooled, (E/T) (H.D.R.)

43131 (CEND–337(Vol.3)) 1000 Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY: REPORT OF TASKS II AND III. A REFERENCE CONCEPTUAL DESIGN OF A 1000 Mwe LMFBR. VOLUME III. SAFETY AND CONTROL ANALYSES. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Sept. 1968. Contract 31-109-38-1999. 189p. Dep. CFSTI.

For Argonne National Lab., Ill.

A trade-off study of cylindrical and modular cores has been made in order to determine the relative merits of each type. The cores compared are optimized to be as realistic as possible. However, they are all unrodded and unmoderated so the effect of these materials is not included. Among items considered are fuel cycle economics, breeding and safety, for both credible and hypothetical accidents. The results of the trade-off indicate the existence of a definite advantage of the cylindrical core over the modular design in the areas of fuel cycle costs, breeding and mechanical design. The fuel cycle costs for the cylindrical core are approximately 0.3 mill/kWh less than for the optimum modular core. Compound doubling time of the cylindrical core is approximately two-thirds that of the modular core. In the safety area, there appears to be no clear advantage of either cylindrical or modular core type, since both types meet basic safety criteria and the design requirements for their safety systems are essentially the same. Furthermore, the modular arrangement was found to have a theoretical inherent disadvantage in its response to certain meltdown accidents which tends to balance its theoretical inherent advantage in response to certain voiding accidents. The study resulted in two basic conclusions pertaining to safety: (a) A flat cylindrical core with a moderately positive sodium void coefficient can be designed to meet the basic safety criteria which are required to obtain an acceptably safe and reliable reactor; (b) The comparison of the reference cylindrical and modular concepts indicates that it will not be significantly easier to make the modular concept an acceptably safe and reliable reactor, despite its slightly negative sodium void coefficient. Based on the foregoing, the optimum core selected for the reference 1000 MW(e) reactor is a short cylindrical core with a moderately positive sodium void coefficient. 26 references. (auth)

43132 (CONF-670846–, pp 70-94) NUCLEAR SAFETY RESEARCH AND DEVELOPMENT. Cottrell, W. B. (Oak Ridge National Lab., Tenn.).

The water power reactor safety program activities are described and the major government and industry users of the program output are identified. The accident sequence structure and causes and effects are discussed. Nuclear safety research tasks sponsored by the AEC are tabulated, and the ORNL nuclear safety program is reviewed. (H.D.R.)

43133 (DOCKET-50322–13) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 7. (Long Island Lighting Co., Mineola, N. Y.). Aug. 22, 1969. 276p. Dep. CFSTI.

Details on the design of the containment system for the Shoreline Power Reactor are given; methods for analyzing seismic and accident loadings are described. The gaseous radwaste system is discussed; activities are tabulated as a function of isotope for specified holdup time in the holdup tank. The mixing model used for coolant loss accident analysis is described. Schematics show details of the containment base, liner plate, and reactor building standby vent system. The complete quality assurance program is detailed. Effects of varying parameters in the probable maximum hurricane analysis are evaluated. Models used in blowdown analyses for water cooled reactors are compared briefly. Detailed meteorological calculations are given for the Shoreham site; a computer printout of data from the modal analysis of the containment structure is included. (M.L.S.)

43134 (ORNL-TM-2412(Pt.2)) DESIGN CONSIDERATIONS OF REACTOR CONTAINMENT SPRAY SYSTEMS. PART II. REMOVAL OF IODINE AND METHYL IODIDE FROM AIR BY LIQUID SOLUTIONS. Patterson, C. Stuart; Humphries, William T. (Furman Univ., Greenville, S. C. Dept. of Chemistry). Aug. 1969. Contract W-7405-eng-26. 30p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Experimental techniques for studying the efficiency of removal of elemental I_2 and CH_3I from air streams by reactive aqueous solutions are described. The procedures are designed to allow rapid comparisons under conditions which simulate those encountered in spray or pressure-suppression-pool applications. A gas-titration procedure for comparing the I_2-scrubbing capabilities of solutions is described, and the results of its use in screening approximately 100 solutions and mixtures are reported. A detailed comparison of NaOH and $Na_2S_2O_3$ is made. A gas-chromatographic method for comparing the relative rates of CH_3I uptake is described, and results for several of the best additives are reported. Conclusions and recommendations for spray and pool systems are included. (auth)

43135 CONTRIBUTION TO THE THEORY OF UNCONTROLLED PROMPT CRITICAL EXCURSIONS IN LIQUID METAL COOLED FAST REACTORS. Azzoni, P.; Carpene, A.; De Cecco, L.; Randles, J. (CNEN, Bologna). J. Nucl. Energy, 23: 315-30(July 1969).

In models of the Bethe–Tait type for the analysis of destructive accidents in fast reactors it is commonly assumed that all the coolant is boiled out of the core prior to disassembly. The fuel density in such models is therefore a constant equal to the mass of fuel divided by the total core volume available to it (after expansion into voids). This viewpoint is modified by supposing that the coolant remains trapped in the core during disassembly and therefore that the density of the fuel becomes a variable depending on the compression and ejection of the coolant. A model of the compression and ejection process is given and coupled into the Bethe–Tait scheme. The resulting assembly of equations (which was coded into an IBM 7094 computer program SPES) is applied to the reactor PEC proposed by the CNEN. It is concluded that the coolant is a very important component in the determination of the mechanical energy release caused by the fuel (that caused by the subsequent boiling of the coolant is not treated). In particular, it is shown that a calculation which assumes the coolant to be totally removed prior to disassembly can give a mechanical energy release of about two orders of magnitude greater than a calculation in which the coolant is assumed to remain. (auth)

43136 SAFETY FEATURES OF AN ADVANCED GAS COOLED REACTOR. Schatz, A.; Kley, H. (Brown, Boveri, and Cie. AG, Mannheim, Ger.). Kerntechnik, 11: 371-8(July 1969). (In German and English).

Based on a brief structural description of the AGR, the various inherent and structural containment barriers for fission products are discussed. The operational features important from the safety point of view are singled out. The action of the reactor safety system is described. The transient behavior of the reactor in the event of coolant and of reactivity disturbances is analyzed and the radiological effects of these disturbances are discussed bearing in mind the containment barriers involved. It is shown that the inherent safety features of the AGR make it independent of the location of its site. 5 references. (auth)

43137 SAFETY-RELATED OCCURRENCES REPORTED IN APRIL–MAY 1969. Cramer, E. N. Nucl. Safety, 10: 436-9 (Sept.-Oct. 1969).

The following safety-related occurrences are briefly summarized: a decrease in fuel element temperature during full power operation of the U. S. Geological Survey's TRIGA reactor; the coolant loss accident at Lucens (in Switzerland); TRIGA pneumatic control rod drive problems; overexposure of a neutron radiographer at the Chapman Division of the Crane Co.; inhalation of ^{131}I by two employees of the Cambridge Nuclear Corp. while dispensing radiopharmaceutical orders; Elk River weld inspections; power uprating, stuck rod, and loss of off-site power at Connecticut Yankee; overexposure of a neutron radiographer at the Norfolk Naval Shipyard; and fuel rod failures at Big Rock Point. 15 references. (M.L.S.)

43138 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. Nucl. Safety, 10: 443-63(Sept.-Oct. 1969).

Progress summaries are given for the following research and development projects: Integrity of Primary Systems; Loss of Coolant–Emergency Core Cooling; Containment Integrity and Siting; Reactor Kinetics and Related Studies; Fission Product Behavior and Control; and Reliability Standards, Guides, and Codes. 57 references. (M.L.S.)

43139 NUCLEAR SAFETY. Volume 10, Number 5. Cottrell, William B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Laboratory, Sept.-Oct. 1969. 119p. GPO $0.60.

The bi-monthly nuclear safety journal contains material and articles on the following topics: A Comparison of Canadian and U. S. Siting Policies; Safety Considerations of Fast-Burst Reactors; German Practices with Respect to Reactor Siting; The Irradiation Performance of Uranium–Plutonium Oxide Fuel Pins; Potential Metal–Water Reactions in Light Water Cooled Power Reactors; Training Nuclear Power Plant Operators with Computerized Simulators; The Reactivity Balance as an Anomaly Detector; Second International Symposium on Packaging and Transportation of Radioactive Materials; In-Vivo Counting of Transuranium Nuclides in the Human Lung; A Shift Supervisor's Introduction to Practical Local Meteorology; Safety-Related Occurrences Reported in April–May 1969; Anomalous Increase in Reactor Power Level at MURR; and Progress Summary of Nuclear Safety Research and Development Projects and other current events. (M.L.S.)

For abstracts of individual papers see: 41330, 41759, 43071–43076, 43103, 43137, 43138, 43165, and 43166.

43140 DESIGN AND SAFETY IN LARGE FAST POWER REACTORS. Okrent, D. (Argonne National Lab., Ill.). At. Energy Rev., 7: No. 2, 135-223(1969).

The design measures taken with regard to safety for Na-cooled fast reactors are reviewed. Following a brief examination of safety issues and phenomena, primarily those associated with integrity of the core, some of the safety-related design features of fast reactors currently in operation or under construction are summarized. The approach to fast reactor safety adopted by various United States design groups in 1963–64 for conceptual studies of large fast reactors is compared with the reference designs presented by the same and other groups at the International Conference on Sodium Technology and Large Fast Reactor Design held at Argonne in November 1968. It is seen that opinions concerning the appropriate design approach to fast reactor safety are in a state of flux, varying from country to country, from designer to designer, and, with time, within a design group. The review concludes by posing some safety-related design and regulatory questions. 168 references. (auth)

Power Conversion Systems

43141 OPTIMIZATION OF HEATER DESIGN CONDITIONS IN POWER PLANT CYCLES. Salisbury, J. Kenneth (Thermal Power Systems, Atherton, Calif.). J. Eng. Power, 91: 159-72 (July 1969).

A method of tailoring the regenerative feedwater-heating system in a nuclear plant to the availability of extraction openings on the main turbine is described. This is accomplished by optimizing the heater design conditions of each individual heater, in conformance with the peculiarities of the particular cycle being used, and the evaluation parameters that are applicable. It is shown by example that for a typical six-heater, reheat nuclear plant the evaluation is improved. The results show that such total optimization in an 880 M(W)e plant will accomplish: an improvement of 27 Btu/kWh in heat rate; an increase of 2500 kW in net output (at constant reactor thermal power); and an increase of about 18.5 percent in heater surface in the reference cycle, for the selected values of the heat rate and incremental kW evaluation parameters, and heater surface cost of $10/ft^2. However, if an incremental heater cost is used, at $6/ft^2, optimum evaluation yields: an improvement of 45.3 Btu/kWh in heat rate; an increase of 4200 kW in net output (at constant reactor thermal power; and an increase of about 42 percent in heater surface. For this set of conditions, there is an improvement in evaluation of about $300,000 for the 880 MW(e) plant. (auth)

43142 GAS TURBINE FAST REACTOR DESIGN. Lys, L. A.; Broido, J. H.; Frutschi, H. J. Brit. Nucl. Energy Soc., 8: 213-22(July 1969).

Safety principles are formulated for the combination of gas turbines with gas-cooled fast reactors. Designs of several integrated circuits are compared. Examination of closed gas turbine reactor cycles shows the importance of heat exchanger size on thermal efficiency. Costs are assessed by consideration of various optimum design parameters as a function of efficiency. Special problems of design and development relating to turbomachinery are discussed. (UK)

Research and Test Reactors

Refer also to abstracts 40622, 40676, 40912, 40913, 41038, 41110, 41112, 41131, 41144, 41148, 41573, 43086, 43135, and 43181.

43143 (AAEC/TM–497) MEASUREMENT AND THEORETICAL ANALYSIS OF DIFFERENTIAL NEUTRON ENERGY SPECTRA FOR SLAB LATTICES OF MULTIPLYING MEDIA. Dalton, A. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1969. 32p. Dep.

Chopper measurements were made of the neutron energy spectrum in the BeO moderator of slab lattices containing fuel enriched in either ^{235}U or ^{233}U for wide ranges of fuel to moderator ratios. The energy range extended from thermal up to about 350 eV. Theoretical predictions of the spectra for the same slab lattices were made using computer programmed transport theory calculations. Excellent agreement was obtained with the measured spectra. (auth) (Australia)

43144 (CEA-CONF-1236) USE OF CORRELATION METHODS FOR THE DETECTION OF LOCAL BOILING IN A LIGHT WATER REACTOR. **Zwingelstein, Gilles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 20, 1968. 7p. (In French). (CONF-681211-1). Dep.**

From Conference on Application of Treatment of the Signal, Grenoble, France.

Methods of detection of in-core boiling in reactors and the Fourier transform methods for analysis of frequency characteristics are discussed. The experimental setup, using two detectors, for noise detection is described; the associated electronics and processing of signals are outlined. Results of noise measurements in the Siloette reactor are discussed briefly. Autocorrelation functions are shown for the cases of boiling and non-boiling. (M.L.S.)

43145 (CONF-670338, pp 289-98) INSTITUTE OF NUCLEAR ENGINEERING IN BRAZIL. **Schneider, L. F. V. (Comision Chilena de Energia Nuclear, Santiago).**

The Institute of Nuclear Engineering was created in January 1962 when the Brazilian National Nuclear Energy Commission signed an agreement with the Federal University of Rio de Janeiro. The Institute consists of five Divisions: Administration, Reactors, Nuclear Physics, Instrumentation and Control, and Reactor Engineering. The first Brazilian-built research reactor — an Argonaut-type — is operated by the Institute for the Nuclear Energy Commission. The current research activities of the Institute are described, as well as the long-range plans necessary for its future growth. The objective of the Institute is to advance the peaceful uses and application of nuclear energy to the future development of Brazil. (auth)

43146 (CONF-670338, pp 321-44) RESEARCH REACTORS: A TOOL FOR NUCLEAR EDUCATION AND RESEARCH. **Graff, A. P.; McMain, A. T. Jr.; Schnurer, G. T. (Gulf General Atomic, Inc., San Diego, Calif.).**

The ways in which research reactors are now being used to implement research and educational programs in Latin American universities, industrial laboratories, medical institutes and government facilities are described. The design and performance of typical TRIGA research reactor facilities are illustrated and discussed. (auth)

43147 (GA-9259) FAST REACTOR SPECTRUM MEASUREMENTS. **Technical Summary Report, May 1, 1968–January 31, 1969. Preskitt, C. A.; d'Oultremont, P.; Young, J. C.; Neill, J. M. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 28, 1969. Contract AT(04-3)-167. 100p. Dep. CFSTI.**

Three assemblies were studied in the Subcritical Time-of-Flight Spectral Facility (STSF). These included a small assembly of BeO, ^{235}U, and ^{238}U designed for an integral measurement of alpha for ^{239}Pu and two large assemblies with compositions typical of dilute-oxide-fueled LMFBR's. The latter assemblies were zoned configurations with central zones identical to Assembly 6 of ZPR-6. The zoned configuration studied in the STSF was identical in loading to Assembly 19 of ZPR-9, one of a series of cores used to study the physics of zoned fast assemblies. New and more accurate data reduction techniques have been applied to data obtained on the ^{235}U-graphite assembly studied as the first loading of the reactor. A substantial analytical effort has been applied to the program. This has included considerable detail work on the calculation of spectra for the cores studied as well as a concentrated effort to develop a new technique for performing resolution corrections to time-of-flight data. Particular interest is attached to the large oxide assemblies studied. The first of these cores contained sodium in amounts typical of a dilute LMFBR and the second was identical except that all sodium was removed. Thus, the inherent accuracy of time-of-flight techniques was applied to the important sodium void problem of an LMFBR. In fact, a significant discrepancy is observed in the effect of sodium on the spectrum and this appears to comment on the adequacy of the sodium cross sections used. The two oxide assemblies had been studied by ANL in the ZPR-6 reactor. Spectral measurements using proton recoil gas proportional chambers were performed by ANL in ZPR-6 and these have been compared with time-of-flight measurements. Large discrepancies in this comparison appear below 50 keV, as well as in certain other regions. During the course of developing the analytical tools for resolution corrections, a series of time-dependent studies in some assemblies was performed. These have been valuable in confirming details of the time-dependent calculations needed for resolution corrections, but have been interesting as well since they provide an understanding of subcritical fast reactor kinetics. For the large zoned oxide LMFBR systems no asymptotic (i.e., exponential) prompt mode was observed. A qualitative understanding of this result in terms of the energetic harmonics to be expected in such a system was developed. (auth)

43148 (TRG-Report-1539) VERA CORE 18: AN ASSEMBLY BUILT TO TEST CALCULATION METHODS AND DATA FOR D.F.R. **Smith, J. C.; Atkinson, H.; McTaggart, M. H. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). July 20, 1967. 40p. Dep. CFSTI. UK 5s. 6d.**

Vera core 18 was built to simulate DFR. The core composition was chosen to give a similar central spectrum, critical size and enrichment. At one side of the core a Ni reflector similar to that of DFR was built. Two versions, cores 18A and 18B, had 14.1 and 23.4 cm thick Ni zones respectively. In both versions radial and vertical reaction rate distributions were measured in the core and in the Ni region. ^{235}U and ^{238}U fission detectors, Mn foils, a BF_3 counter and foils for the ^{238}U (n,γ) reaction were used. A configuration similar to a partially inserted control rod in DFR was devised and selected reaction rate measurements made in its vicinity. (auth)

43149 ISOTOPIC COMPOSITION OF FISSION PRODUCTS IN PRIMARY CIRCUIT GAS OF BR-5 REACTOR WITH UC FUEL ASSEMBLY. **Efimov, I. A.; Kravchenko, V. P.; Filonov, V. S.; Shereshkov, V. S. At. Energ. (USSR), 26: 544-6(June 1969). (In Russian).**

Isotopic composition of fission products in the primary circuit gas of the BR-5 reactor operating at nominal power with unsealed fuel elements is studied. The experiments were carried out during May, 1968 when the initial activity of fission products in the circuit increased by an order of two due to the dehermetization of fuel elements. Tabulated data are given on the concentration of isotopes in the pump gas of the first circuit with trap for sodium oxides. Obtained data showed that the gas region contained only inert gases and products of their decay (^{138}Cs and ^{88}Rb), and that the concentration of inert gases depends on the performance of the cold trap for sodium oxides. Trap cut-off increased the concentration of long-life gases (^{135}Xe) and left unchanged concentrations of short-life isotopes (^{138}Xe and ^{87}Kr). The experiments confirmed the ability of sodium coolant to retain all fission products except inert gases. (R.V.J.)

43150 THE RISE OF ACTIVE WATER FLOW IN THE OSIRIS REACTOR POOL. **Lerouge, B.; Huffenus, J.-P.; Lambert, P. Houille Blanche, 23: 711-24(1968). (In French).**

The Osiris swimming pool type reactor has been in operation at the Nuclear Research Center at Saclay since 1966. General problems encountered in designing the circulation system for this type of reactor are discussed. The hydraulic research and tests which confirmed the validity of the proposed scheme are described. Due to the site background, the only reasonable way to achieve the desired 50 MW rated output was by designing for rising flow in the core, which also meant taking steps to counter the following possible undesirable effects: excessive pool temperature increase due to large-scale heat exchange between the hot core outflow and the colder water in the pool; and unacceptable activity on the pool surface, which would impair ease of operation enabling convenient direct access to the core, which is one of the main advantages of this kind of reactor. The proposed design reduces the upflow of warm water from the core in the pool to a minimum with the least possible adverse effect on flexible reactor operation. (BBB)

43151 THE ESCAPE OF ^{23}Ne FROM THE SODIUM COOLANT INTO THE GAS CAVITIES OF THE BR-5 REACTOR. **Efimov, I. A.; Kulikov, Yu. K.; Filonov, V. S. At. Energ. (USSR), 26: 463(May 1969). (In Russian).**

The short-lived ^{23}Ne, resulting from the activation of sodium by fast neutrons, was used to study the leakage of inert gases into the argon-filled gas cavities of the BR-5 reactor. The leakage rate was determined with a spectrometer in a bypass line installed in the primary loop under turbulent flow conditions of Reynolds no. >10,000. The gas was pumped continuously to check the leak tightness of the fuel cladding system. The measurement involved a recording of the neon in the sodium and in the gas by means of a scintillation detector and pulse height analyzer. The measuring system was switched into the loop when the reactor was shut down and the 0.43-MeV line of ^{23}Ne was determined every 10 seconds. The results indicated that the effective half-life of ^{23}Ne in the coolant at a sodium temperature of 290°C was 20 ± 2 sec; its effective release half-life was 50 ± 10 sec; at the escape rate, there is a (45 ± 10)% probability that the neon leaks into the gas cavity at a fairly high rate. The flow rate was not affected by an increase of the power level from a few kilowatts to 5 MW but it was affected by the temperature of the coolant. (TTT)

43152 DEVELOPMENT OF THE RADE KONCAR AUTOMATIC POWER CONTROL SYSTEM OF TRIGA REACTOR. Brezinscak, Marijan; Lavicki, Damir; Miljan, Iva; Smiljanic, Danijel; Saban, Ivka (Rade Koncar Enterprise, Zagreb). pp 307-17 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968.

See CONF-680642.

The automatic power control system for the Triga reactor is described. The voltage input information is converted by means of a voltage-to-frequency converter to a low frequency (0 . . . 3 Hz) three phase system, which controls the speed of a synchronous reluctance motor. Micrologic circuits have been used, and the output stage is a thyristor cycloconverter. (auth)

43153 TESTING OF REACTOR CONTROL SYSTEM WITH SYNCHRONOUS RELUCTANCE MOTOR ON TRIGA REACTOR. Borovsak, M. (Nuclear Inst. Josef Stefan, Ljubljana, Yugoslavia); Gabrovsek, Z.; Lavicki, D.; Mihelcic, B.; Ogrin, R.; Pisanski, C. pp 319-31 of Proceedings of the Third International Meeting on Electronics and Automation, Herceg Novi, Yugoslavia, 24–29 June 1968. Kicovic, E. (ed.). Belgrade, Boris Kidric Inst. of Nuclear Sciences, 1968.

See CONF-680642.

Testing of a control rod drive assembly with a synchronous reluctance motor is described. The tests were performed on a TRIGA MARK II reactor. For this purpose the automatic power control system, safety circuits and rod drive mechanism were developed. The dynamic characteristics of the developed reactor control system have been compared with the responses of the standard TRIGA instrumentation. (auth)

43154 DEVICES FOR HOLDING A SAMPLE TO BE IRRADIATED IN A NUCLEAR REACTOR. Javellaud, Jean; Robin, Marc; Dupuy, Gerard (to Commissariat a l'Energie Atomique). U. S. Patent 3,454,465. Priority date May 23, 1966, France.

The invention is concerned with a device for holding a sample to be irradiated in a nuclear reactor containing a liquid moderator. The vertical tubular container in which the sample is placed is hanging through a ball and socket joint from the top part of a prismatic water box mounted pivotally at the lower part about a horizontal axis. By vertical displacements imparted to a horizontal strap fixed to the box, the latter can be pivoted about the axis, which adjusts the horizontal distance between the tubular container and the core of the reactor while maintaining the container in vertical position. (Offic. Gaz.)

43155 DYNAMIC MODEL AND EXPERIMENTAL CONTROLLER FOR THE LIVERPOOL AND MANCHESTER UNIVERSITIES RESEARCH REACTOR. Maudsley, D.; Walker, P. A. W. (Univ. of Liverpool). J. Brit. Nucl. Energy Soc., 8: 223-31(July 1969).

A description is given of the development of a mathematical model of the Universities Research Reactor, an Argonaut type reactor. The reactor is considered to be a point source of neutrons with one average delayed neutron group; the fuel and coolant temperature coefficients of reactivity are also included. The frequency and transient responses of the model are compared with results obtained from experiments on the reactor. The design and performance of an experimental continuous control loop is described. It is shown how, using the model transfer function, appropriate settings for a three-term controller were developed. The root-locus technique was employed to obtain a suitable gain figure. The design of the control rod is such that it may be inserted into one of the $1\frac{1}{2}$ in. vertical access holes which pass between the fuel regions of the reactor. A number of dynamic tests were performed on the control system to evaluate its performance with both fast and slow disturbances. The results of these tests are included. (auth)

43156 REACTIVITY LOSS DUE TO WATER ABSORBED IN THE GRAPHITE REFLECTOR OF THE UNIVERSITIES RESEARCH REACTOR. Bridge, H.; Humphreys, E. (Universities Research Reactor, Risley, Eng.). J. Brit. Nucl. Energy Soc., 8: 237(July 1969).

A brief description is given of the procedure adopted following an incident with the URR 300 kW Argonant type reactor at Risley. During a series of pulsed neutron experiments on a sub-critical low-power core, water flowed over the central tank permeating through the graphite reflector. Criticality was not reached and estimated reactivity was between 0.6 and 0.7 $\underline{\delta k/k}$. (UK)

43157 NUCLEAR REACTOR DUAL FUEL-COBALT CONTROL ROD. Dupuy, G.; Germond, P. (to Commissariat a l' Energie Atomique). Canadian Patent 809,349. Mar. 25, 1969. Priority date Sept. 16, 1966, France.

A control rod for a swimming pool type of reactor is described which consists of tubular structure, several fuel elements supported by it and a tubular casing housed in the structure and adapted to support a number of cobalt plates clad with stainless steel. Each tubular casing comprises two coaxial elements arranged respectively as an inner and outer element and having a square cross-sectional configuration. Thus an annular space is formed between the two elements in which the cobalt plates are contained. Temporary fastening means join the casing elements. Several additional variations are also described. The walls of each casing element are provided with holes which permit free circulation of the coolant around the cobalt plates contained in the casing. (F.S.A.)

43158 FEATURES OF UNIVERSITY OF TOKYO FAST NEUTRON SOURCES REACTOR AND ITS CONSTRUCTION. An, Shigehiro (Tokyo Univ.). Genshiryoku Kogyo, 15: No. 4, 31-6(Apr. 1969). (In Japanese).

Construction was started in June 1968 on the Tokyo University fast neutron sources reactor following the type of AFSR and HARMONIE; it is expected to go critical at the end of 1970. The specifications are: heat output, 2 kW; neutron flux, 0.8×10^{12} $n/cm^2 \cdot sec$; fuel, uranium metal with 93 wt % ^{235}U; blanket, depleted uranium; reflector, lead; cooling, forced air; control, depleted uranium. The features of the fast neutron sources reactor are listed. Fast neutron-source reactors in other countries, AFSR, HARMONIE, and TAPIRO, are described. Finally, the Tokyo University fast neutron sources reactor is introduced, including its features and purposes. (NSA of Japan)

43159 THE THERMAL CELL CONTRIBUTION TO THE PROMPT NEGATIVE TEMPERATURE COEFFICIENT OF REACTIVITY OF THE PENN STATE TRIGA REACTOR. Hoover, Leo John. University Park, Pa., Pennsylvania State Univ., 1968. 92p.

Thesis.

The contribution of the thermal cell coefficient to the prompt negative temperature coefficient of reactivity of a TRIGA Mark III reactor has been calculated. The neutron energy range 0.001 to 1.0 eV was employed in a Monte Carlo program which treated the cell geometry and the neutron interactions as exactly as is presently possible. Averaging, splitting, and correlated sampling were utilized as variance reduction techniques. (Disser. Abstr.)

43160 ALL-TRANSISTORIZED ELECTRONIC INSTRUMENTS FOR NUCLEAR INSTRUMENTATION SYSTEMS OF NUCLEAR REACTORS. Kojima, Shigeyoshi (Tokyo Shibaura Electric Co., Ltd.); Kobayashi, Akira; Ohisa, Tadao. Toshiba Rev., Int. Ed., No. 41, 31-8(Mar.-Apr. 1969).

Development of transistorized nuclear instrumentation is discussed; application of the developments to the JMTR is described. Each instrument component is described briefly; an overall schematic is included. (M.L.S.)

43161 EXPERIMENTAL FACILITY FOR THE SHORT TERM IRRADIATION OF BREEDER REACTOR FUEL PINS IN THE FR 2 REACTOR. Deckers, H.; Reiser, H. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 11: 403-8(July 1969). (In German and English).

A special short term irradiation facility was built in the FR 2, making use of the available experimental helium loop. With this facility it is possible to insert a short fuel pin through a lock into the irradiation rig at a pressure of 30 kgf/cm^2 during reactor operation at full output, and to irradiate it up to a high power output. The facility has been in operation since 1966 within the framework of the project Fast Breeder. The design and the functioning of the irradiation rig and of the change-over system are described. Experience gained in preliminary operation is presented. (auth)

43162 ESSOR: AN EXAMPLE OF GERMAN–FRENCH COOPERATION. Naigeon, J. Atomwirt., Atomtech., 14: 314-16(June 1969). (In German).

The overall ESSOR program is described. The combined French–German efforts in the areas of design, fabrication, and development for the project are summarized. (M.L.S.)

43163 ROTATING HOLDER FOR IRRADIATING SAMPLES. Hendrickson, W. F. (Washington State Univ., Pullman). Nucl. Appl., 6: 102(Feb. 1969).

Design parameters for a 1 rpm rotating sample holder for research reactors experimental facilities are presented. (auth)

43164 MEASUREMENT OF NEUTRON SPECTRA IN GRAPHITE–WATER SYSTEM WITH A TEMPERATURE DISCONTINUITY. Abdullaev, Kh. Sh.; Dikarev, V. S.; Mostovoi, V. I.; Taraban'ko, V. A. At. Energ. (USSR), 27: 116-20(Aug. 1969). (In Russian).

Neutron spectra in a system consisting of a $100 \times 100 \times 59.5$ cm^3 graphite stack and an adjacent cylindrical water tank 38 cm in diameter were measured by the time-of-flight method with a temperature discontinuity between graphite and water. The measurements were carried out with temperature of graphite of 133, 303, 359, and 443°K and temperature of water of about 300 and 343°K. The measurement results show sharp increasing of relaxation length of the neutron temperature in graphite with decreasing of graphite temperature (from 6.2 cm at graphite temperature of 443°K to 17.6 cm at 133°K). For the geometry of the present installation cooling of graphite to 133°K increases by a factor of two the flow of neutrons with energies lower than 0.02 eV. 11 references. (auth)

43165 SAFETY CONSIDERATIONS OF FAST-BURST REACTORS. De La Paz, A. (Nuclear Effects Directorate, White Sands, N. Mex.). Nucl. Safety, 10: 372-7(Sept.-Oct. 1969).

The evaluation of the safety of fast-burst reactors requires consideration of factors specific to this type of reactor, in addition to concepts generally applicable in nuclear reactor safety. The principal considerations that specifically apply to fast-burst reactors include their lower fission-product inventory and the critical importance of the administrative procedures that apply. Because of their unique characteristics, including the type and consequences of the accidents that could be postulated to occur, the limiting safety criterion is the safety of the reactor site and the personnel located therein, rather than limitations directly associated with the general public. Factors that must be provided for, in addition to the administrative procedures, include the establishment of the reactor characteristics during initial operation and the incorporation of these results into the requirements applicable to experiments subsequently proposed for performance at the reactor. 26 references. (auth)

43166 ANOMALOUS INCREASE IN REACTOR POWER LEVEL AT MURR. Cox, E. L. Nucl. Safety, 10: 440(Sept.-Oct. 1969).

During routine operation at full power, two power-level channels suddenly showed increasing readings, whereas three others held steady and stack radiation levels increased. The reactor was shut down, and water inleakage to a dry beam tube normally water filled was found to be disturbing the power-to-flux calibration of the neutron-sensitive channel automatically controlling reactor power. The ^{41}Ar that had built up while the beam tube was air filled was forced out by the incoming water and released to the stack. (auth)

43167 DIAGRAMS FOR DIRECT CALCULATION OF NUCLEAR REACTOR LIMIT CYCLES. Cocquyt, G.; Jansen, G. (Centre d'Etude de l'Energie Nucleaire, Mol-Donk, Belg.). pp 271-86 of Automation and Instrumentation, 1968. Milan, Federation of Scientific and Technical Associations, 1968.

From 10th International Automation Conference, Milan, Italy. See CONF-681130-(Vol.2).

On-off control of zero power reactors (critical experiments) is discussed in the case of constant control rod speed in both directions and diagrams are given to calculate the amplitude almost directly. They are based essentially on the approximation of H. Smets for nuclear reactors. This approximation is valid for $\delta k^2 \ll 1$ and may be applied practically to any case, except nuclear accident and reactor scram which are not considered here. Different groups of delayed neutrons are considered and it seems necessary to consider at least two equivalent groups, if a good approximation is desired. The equations are given for the case of on-off regulation compensated by means of the period meter signal. An extension of Hamel's method is then given for the calculation of limit cycles in the case of asymmetrical limit cycles. (auth)

43168 FAST REACTOR PHYSICS AT STUDSVIK. Hellstrand, Eric; Tiren, Ingmar (Aktiebolaget Atomenergi, Nykoeping, Sweden). Tek. Tidskr., 99: 455-8(1969). (In Swedish).

A review is given of the fast reactor physics research programme at Studsvik Nuclear Research Establishment. The experimental work at the zero-effect fast research reactor FRO is briefly described. (Sweden)

43169 RESEARCH NUCLEAR REACTOR. CLASS 90, No. 227932. Bulkin, Yu. M.; Konstantinov, L. V.; Lobanov, V. S.; Nikolaev, V. A.; Khryastov, N. A. Izobret., Prom. Obraztsy, Tovarnye Znaki, No. 30, 184(1968). (In Russian).

An Author Certificate has been issued for a pool-type nuclear reactor with natural circulation of water and a heat exchanger. To improve the natural circulation, the reactor contains a concentric cylindrical baffle lowered below the core separating the core and the space above it. This space above the core is filled with hot water from the space between the baffle and the reactor vessel, while this latter space is filled with cold water. To assure a uniform distribution of fuel elements inside the core and to retain the stability and mutual distribution of fuel element assemblies, each of these assemblies has a tubular support rod equipped with a stem at the base. The stem is inserted into a support structure at the reactor base. The stem has a star connection at the top of the rod, serving as a spacer for the fuel elements and an end piece for the retrieval of fuel element assemblies from the reactor. The fuel elements are located around the support rod with one fuel element located inside the rod along its axis. (JPRS)

Rocket and Space Reactors

Refer also to abstract 42017.

43170 (CONF-670846-, pp 1-29) NUCLEAR SYSTEMS FOR SPACE POWER AND PROPULSION. Lafleur, J. D. (Atomic Energy Commission, Washington, D. C.).

The space nuclear power systems under development in the Systems for Nuclear Auxiliary Power (SNAP) and the Nuclear Engine for Rocket Vehicle Application (NERVA) programs are reviewed. Solar, dynamic chemical, and radioisotope power systems are described, and the SNAP radioisotope systems and reactor systems design characteristics are summarized. The evolution of the NERVA propulsion system is briefly described. (H.D.R.)

43171 (N-69-18586) CAVITY REACTOR CRITICAL EXPERIMENT. VOLUME 3. Pincock, G. D.; Kunze, J. F. (General Electric Co., Idaho Falls, Idaho. Nuclear Systems Programs). Nov. 15, 1968. Contract C-67747-A. 330p. (NASA-CR-72384; GESP-129(Vol.3)). CFSTI.

Experiments designed to investigate the effects of specific engineering design factors needed for an operating power reactor and how these factors influence the ultimate critical mass of the system are described. Included are effects of a linear material to protect the cavity wall from thermal and pressure effects, the hydrogen propellant gas that will occupy the space between this liner and the core, and the appropriate placement of fuel in the reflector in order to reduce the required critical mass in the core. (auth) (STAR)

43172 (N-69-23450) INITIAL RADIO-FREQUENCY GAS HEATING EXPERIMENTS TO SIMULATE THE THERMAL ENVIRONMENT IN A NUCLEAR LIGHT BULB REACTOR. Kendall, John S.; Roman, Ward C.; Vogt, Paul G. (United Aircraft Corp., East Hartford, Conn.). Apr. 1969. Contract NASw-847. 105p. (NASA-CR-1311; G-910091-17). CFSTI.

Initial experiments were conducted to develop an intense radiant energy source which would eventually be capable of producing radiant energy fluxes equal to those expected in a full scale nuclear light bulb engine. The test program was conducted using the UARL 1.2-MW r-f induction heater at dc input power levels up to approximately 250 kW to supply energy to the simulated fuel containment region of a vortex. The primary objective of the experimental program was to determine the effect of various parameters on the power radiated from the vortex, the power deposited in the peripheral wall of the vortex tube, and the power carried away by convection from the vortex. Both Ar discharges with no seed and Ar discharges seeded with submicron carbon and tungsten particles were employed. Tests were conducted at discharge pressures up to 6.0 atm abs and with up to 85 kW of power deposited in the discharge; of this, 35 kW was radiated through a water cooled transparent wall surrounding the discharge. The 35 kW of radiant energy represents a radiant energy flux of about 12.0 kW/in.^{2} (1.86 kW/cm^2), which corresponds to an equivalent black body radiating temperature of 7600 R. (auth) (STAR)

43173 (N-69-23451) NUCLEAR STUDIES OF THE NUCLEAR LIGHT BULB ROCKET ENGINE. Latham, Thomas S. (United Aircraft Corp., East Hartford, Conn.). Apr. 1969. Contract NASw-847. 81p. (NASA-CR-1315; G-910375-3). CFSTI.

Analytical studies were conducted to determine ^{233}U critical mass requirements, neutron kinetic behavior, and neutron and gamma ray heating rates for the nuclear light bulb rocket engine. The nuclear light bulb is a multiple-cavity gaseous nuclear rocket engine in which energy is transferred by thermal radiation from gaseous nuclear fuel through internally cooled transparent walls to seeded hydrogen propellant. The engine considered employs seven separate cavities, each having a length of 6 ft and an average diameter of 2.3 ft. Beryllium oxide is employed between the unit cavities, and layers of BeO and graphite surround the seven units to provide neutron reflection. The criticality analysis allowed the effect of engine design changes on critical mass to be investigated. Among the factors that were varied were the total moderator mass, the amount of BeO between unit cavities, the distribution of moderator mass, the amount of tungsten seed in the hydrogen propellant, and the amount of hafnium required to shield the fuel injection and recirculation system ducts. The analysis also considered factors affecting the kinetic behavior of a nuclear light bulb engine. (auth) (STAR)

43174 (N-69-24802) ANALYSIS OF CYLINDRICAL REACTOR FUEL PIN FOR CLAD STRESS CAUSED BY FISSION GASES. Gedeon, Louis; Lietzke, Armin F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1969. 22p. (NASA-TN-D-5178). CFSTI.

An analysis of a reactor fuel pin with a central void is presented which considers stresses in the clad caused by fission gas pressure. It is shown that, for a given fuel volume, the clad and void volumes may be optimized to give a minimum stress in the clad. Stress and strain in the clad may be calculated from equations and graphs of a stress parameter as a function of a heat generation parameter and the fuel to pin volume ratio. An illustrative example is presented showing how the analysis and creep properties of the clad may be used in conjunction with reactor criticality calculations. (auth) (STAR)

43175 (N-69-25305) RADIAL POWER TAILORING FOR A URANIUM DIOXIDE T-111 CLAD REACTOR WITH CONTAINED FISSION PRODUCT GASES. Mayo, Wendell; Westfall, Robert M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1969. 21p. (NASA-TM-X-1795). CFSTI.

A method is presented to evaluate the power capability of a nonvented reactor design which meets required excess reactivity and control requirements without undergoing more than 1 percent diametric creep in the T-111 fuel pin cladding. Optimized 3 fuel zone power tailoring allows a power level of 2.83 megawatts thermal compared to 2.42 for the unzoned reactor. An extension of the method is used to change core size while meeting all other requirements to obtain 3-megawatts-thermal power. The unzoned reactor size is 50.1 centimeters in length and equivalent circular diameter compared to 47.8 for the zoned reactor for 3-megawatts-thermal power. (auth) (STAR)

43176 (WANL-TME-1897) APPLICATION OF FRACTURE MECHANICS TO THERMALLY STRESSED CYLINDERS USING A FINITE ELEMENT METHOD. DeSalvo, G. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Mar. 1969. Subcontract SNP-1. 36p. Dep. CFSTI.

A method for obtaining the thermal stress intensity factor for a hollow cylinder with internal heat generation is described. The model is chosen to represent a section around a cooling hole in the reflector of the NERVA reactor. The stress intensity factor is determined as a function of radial crack length for various heat generation rates, material properties and geometries. The stress intensity factor is related to the equivalent thermal stress at the inner wall. A comparison between this allowable stress and the stresses obtained from approximate mechanical models shows close agreement only for small crack lengths. In all cases the mechanical models give conservative estimates. (auth)

43177 APPLICATION OF SOLID-CORE REACTORS FOR NUCLEAR POWERED ROCKETS. Thery, Pierre. Energ. Nucl. (Paris), 11: 144-53(May 1969). (In French).

The storage of energy that can be used in an independent system has raised, and still raises a problem that is hard to solve. The specific power of nuclear fuels is extremely high, and this is why the use of nuclear energy has been considered for rockets. First assessments show that beyond the technological difficulties bound up in the high temperatures that allow sufficient energy to be transmitted to the working fluid, it is the problem of heat extraction that determines the overall balance-sheet for the system (mass, thrust, operational time, etc...). An operational U. S. prototype with performances higher than an equivalent conventional rocket has been developed. 10 references. (auth)

43178 CRYOGENICS IN THE NUCLEAR ROCKET PROGRAM. Edeskuty, F. J.; Henshall, J. B.; Bartlit, J. R. (Los Alamos Scientific Lab., N. Mex.). Cryog. Ind. Gases, 4: No. 6, 36-9; 42; 46; 48; 50; 52(June 1969).

A review of the NERVA test program is presented. Descriptions of the test facilities and test procedures are included. The use of cryogenics in NERVA development is described. 15 references. (D.C.C.)

43179 NUCLEAR ROCKET PROGRAM: ITS STATUS AND PLANS. Corrington, L. C. (Space Nuclear Propulsion Office, Cleveland). J. Spacecraft Rockets, 6: 465-70(Apr. 1969).

The nuclear rocket program has been progressing toward the attainment of the necessary technology for the development of the high-performance NERVA engine system, and planning, preliminary design, and preliminary development are underway for this engine system. The NRX-A6 reactor was designed with a duration goal of 1 hr under close control at full power and temperature. This goal was achieved in December 1967, and post-test examination showed that it could have run appreciably longer. The Phoebus 2A, a much larger reactor, was tested successfully in July 1968 and demonstrated the ability to scale up reactor design to higher power density and larger physical dimensions. Groundwork is also being laid for advanced materials and concepts to extend the performance of the NERVA system. The first of a series of much smaller reactors designed to explore advanced ideas in fuel elements and core support, Pewee I, was tested in December 1968. This reactor contained numerous core experiments to be evaluated in post-test examination. Efforts in advanced materials and concepts include high-expansion graphites, graphite-metal-carbide composites, and pure carbides for fuel element applications, studies on shorter and possibly uncooled nozzles, flueric control systems, gas-core reactors, and many other areas that present potential advancements. 12 references. (auth)

43180 JET, ROCKET, NUCLEAR, ION, AND ELECTRIC PROPULSION: THEORY AND DESIGN. Loh, W. H. T. Applied Physics and Engineering. Volume 7. An International Series. New York, Springer-Verlag New York Inc., 1968. 780p. $24.80.

Advances in theory and design in the field of jet, rocket, nuclear, ion, and electric propulsion are presented. The material is presented in such a way that it may be adopted as a textbook for an advanced course on the subject. Emphasis is placed on the interrelation of propulsion systems and their application to various flight missions. The seven major parts discuss: fundamentals of thermodynamics and aerodynamics, jet propulsion, rocket propulsion, nuclear propulsion, electric and ion propulsion, theory on combustion, detonation and fluid injection, and advanced concepts and mission applications. (H.D.R.)

Process Heat and Desalination Reactors

43181 (CONF-670338) NUCLEAR ENERGY AND LATIN AMERICAN DEVELOPMENT. BASED ON THE CONFERENCE ON APPLICATIONS OF NUCLEAR ENERGY IN LATIN AMERICAN DEVELOPMENT, MARCH 22-28, 1967. Smith, Craig B. (ed.) (California Univ., Los Angeles. Nuclear Energy Lab). 396p.

Separate abstracts were prepared on 21 of the 33 papers in this conference. The other papers are descriptions of panel discussions on desalination, radioisotope applications, and nuclear education. Questions and answers are included at the end of each section, and a bibliography of contributors is included at the end of the conference. (E.R.B.)

For abstracts of individual papers see: 40580, 41190, 41191, 41365, 43078–43081, 43145, 43146, 43182–43185, 43210, and 43228–43233.

43182 (CONF-670338, pp 19-33) DESALINATION: THE SURFSIDE PLANT. Schoenbrunn, A. G. (American Macine and Foundry Co., [New York]).

The SURFSIDE plant will produce, simultaneously, a million gallons of fresh water per day, a net electrical power output of 2500 kilowatts and radioisotopes equivalent to 460,000 curies per year of cobalt-60. Despite the fact that this concept is intended for small-scale water and power needs, in contrast to the very large plants now being developed, it is expected to be economically competitive with non-nuclear, small-scale systems in many parts of the world. The SURFSIDE concept was developed by the American Machine & Foundry Company (AMF) in response to a request from the New York State Atomic and Space Development Authority for a plant design suited to the particular requirements of the New York State program. The economics presented are for a generic plant using the SURFSIDE concept. (auth)

43183 (CONF-670338, pp 35-47) BOLSA ISLAND NUCLEAR POWER AND DESLATING PLANT. Holtom, H. T. (Metropolitan Water District of Southern California).

The Bolsa Island plant as proposed would be situated on a man-made island off the coast of Southern California. The plant would consist of two nuclear reactors producing steam for an 1800 MW(e) power plant and a desalting plant of 150 million gallons per day capacity. The proposed site and overall plant layout are described, and some cost estimates are presented. (H.D.R.)

43184 (CONF-670338, pp 49-55) PROGRESS IN NUCLEAR POWER AND DESALINATION. Gould, William R. (Southern California Edison Co., [Los Angeles]).

The rate of nuclear power growth in the United States and prospects for economical desalination are examined. A joint study by the U. S. and Mexico on a dual purpose plant near the border is briefly discussed. (H.D.R.)

43185 (CONF-670338, pp 57-81) FEASIBILITY OF DUAL-PURPOSE PLANTS IN BRAZIL. Pollis, Waldyr; Donadio Baptista, L.; Grimberg, M. (Comissao Nazional de Energia Nuclear de Brasil, Rio de Janeiro).

Areas in Brazil which, while having a sizable population and reasonable economic conditions, suffer from a shortage of fresh water as well as from insufficient supplies of power are discussed. General criteria for locating sites where the utilization of dual-purpose nuclear plants will solve problems of water and power shortage with no appreciable increase in the combined cost of water and power consumption are established. A brief description of the method for determining the cost of water produced in those regions is presented. A general picture of the power situation in Brazil is given, with emphasis on regions where the fresh water supply is deficient and the power supply is precarious. In those regions there are equally valid reasons for and against the use of nuclear fueled plants. In conclusion, a brief study of a dual-purpose nuclear plant recommended for Fortaleza, State of Ceará, where the situation seems to be the most critical, is presented. (auth)

Marine and Portable Power Reactors

Refer also to abstracts 40937 and 43086.

43186 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Peters, Martin Charles (to Babcock and Wilcox Ltd.). British Patent 1,160,553. Aug. 6, 1969. Filed July 6, 1965.

Reference is made to reactors of the integral type, and in particular to such reactors intended for use in ships. In the reactor system described the pressure vessel contains a once-through forced flow heat exchanger, with means defining the flow of liquid coolant and moderator over the core and heat exchanger, together with a separator located external to the pressure vessel to separate the fluid into a vapor component and a liquid component. A turbine is connected to receive vapor directly from the separator. The working fluids may be wet and dry steam. The fluid during operation at less than full load may be superheated steam, with increased moisture content as the load increases. (UK)

Production Reactors

Refer to abstract 43086.

Reactor Theory

Refer also to abstracts 42831, 43095, and 43100.

43187 (AEEW-M-892) RESONANCE EQUIVALENCE PROCEDURE CONVENIENT FOR NUMERICAL USE. Askew, J. R. (Atomic Energy Establishment, Winfrith (England)). May 1969. 11p. Dep. CFSTI. UK 2s. 3d.

A procedure is outlined for calculating the value of σ_p, the equivalent homogeneous hydrogen admixture, appropriate to complicated geometric configurations. In particular, the method deals with arrays containing dissimilar materials in close proximity and calculates the effect of heavy canning materials. The procedure is designed for use in a modular calculational scheme having an appropriate spatial solution module for the geometry needed. A test against established methods for the case of isolated fuel rods shows that the desired accuracy of ~2% in resonance events can be obtained even in extreme cases. (auth) (UK)

43188 (BNL-50149) NUCLEAR ENGINEERING DEPARTMENT ANNUAL REPORT, DECEMBER 31, 1968. (Brookhaven National Lab., Upton, N. Y.). 152p. Dep. CFSTI.

Separate abstracts were prepared for the 8 sections of this report. (L.T.W.)

For abstracts of individual sections see: 40534, 40676, 40677, 40913, 41528, 42828, 43189, and 43225.

43189 (BNL-50149, pp 1-14) REACTOR PHYSICS DIVISION. Chernick, J.; Kouts, H. (Brookhaven National Lab., Upton, N. Y.).

CALIFORNIUM ISOTOPES Cf-254—production by epithermal neutron capture in californium-252
CRITICAL ASSEMBLIES—physics parameter measurements on small reflected
—operating characteristics of Brookhaven machine FS-1
EXPONENTIAL PILES—neutron activation and cadmium ratio measurements in plutonium-aluminum-heavy water lattices
FLUID FLOW—analysis of condensing length in two-phase
NEUTRON SPECTROMETERS—development for use in fast reactor cores
NEUTRONS—resonance integral calculations using trial operators in interative solutions
—thermalization of, analysis of pulse, wave, and poisoning experiments on
REACTOR CONTROL ELEMENTS—movement of interiors, effect on power shape of
REACTORS—physics analysis methods for, development of
—kinetics analysis methods for, development of nonlinear space-independent and space-time
REACTORS, PRESSURIZED WATER—power generation rates in, external detection of local (H.D.R.)

43190 (CEA-R-3798) PRINCIPLE OF THE DETERMINATION OF NEUTRON MULTIPLICATION COEFFICIENTS BY THE MONTE CARLO METHOD: APPLICATION: DESCRIPTION OF A CODE FOR IBM 360-75. Moreau, Jean; Parisot, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 37p. (In French). Dep.

The determination of neutron multiplication coefficients by the Monte Carlo method can be carried out in different ways. Particularly complex geometries are examined. Multi-group isotropic cross-sections are applied. The performances of this code are illustrated by some examples. 4 references. (auth)

43191 (CONF-670846-, pp 95-135) REACTOR DYNAMICS: A FOUNDATION FOR NUCLEAR SAFETY. Hetrick, D. L. (Arizona Univ., Tucson).

The nuclear safety program at the University of Arizona is briefly reviewed. Some results which have been obtained in calculations on the neutron dynamics aspects of reactor safety are discussed. The three areas described are: (1) numerical calculations in reactor dynamics, (2) analytical approximations for calculating reactor excursions, and (3) nonlinear reactor stability. (H.D.R.)

43192 (ORNL-TM-2601) AMPLIFICATION OF SELECTED PORTIONS OF THE 05R MONTE CARLO CODE USER'S MANUAL. Irving, D. C.; Cain, V. R.; Freestone, R. M. Jr. (Oak Ridge National Lab., Tenn.). May 29, 1969. 117p. Dep. CFSTI.

A miscellaneous collection of material useful in using, modifying, and understanding the 05R code is presented. It is roughly grouped into three sections. The first section presents logic flowcharts (supplementing the Fortran flowcharts of the original report) for the important subroutines of 05R. The second section presents logic flowcharts for XSECT, the cross-section handling program. The final section is comprised of logic flowcharts and other material describing the operation of the general geometry package, GEOM. (auth)

43193 (WANL-TME-1813) FLUXPLT: FORTRAN IV PROGRAM TO PLOT ISOFLUX LINES BASED ON THE SCALAR FLUX CALCULATED BY THE DOT PROGRAM. Moran, Larry L.; Soltesz, Richard G. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 21, 1968. 94p. Dep. CFSTI.

FLUXPLT is a FORTRAN IV program which rapidly and economically produces a plot of isoflux lines in the R-Z coordinate system based on the scalar flux calculated by the DOT two-dimensional discrete-ordinates transport program. The calculation methods used to transform the scalar flux into final responses are described. The level of flux to be plotted and the format of the plot are controlled by the user. 4 references. (auth)

43194 (ZJE-47) FINE STRUCTURE OF NEUTRON FLUX IN MODERATOR IN ENERGY RESONANCE REGION. Stech, S. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Feb. 1969. 12p. Dep.

The fine structure of the neutron flux in moderator (FSM) is the consequence of a strong absorption in the low lying resonances (e.g. U 238). This "fine structure" in the layers of moderator near the fuel has the influence on a resonance absorption—the resonance integral (RI). The contribution to the resonance integral is analyzed. The space dependent shape of the flux near a resonance energy is described. The numerical results are related to HWGCR cluster lattice cell. 9 references. (auth)

43195 REPRESENTATION OF ANGULAR DEPENDENCE OF BOLTZMANN EQUATION SOLUTION AS ORTHOGONAL POLYNOMIAL EXPANSION. Broder, D. L.; Sergeev, I. V.; Platovskikh, Yu. A. (Physical-Energetics Inst., Obninsk, USSR). Kernenergie, 12: 125-7(Apr. 1969). (In Russian).

The spherical harmonics method for plane geometry is generalized by the use of the polynomials orthogonal in [−1,1] interval with arbitrary weight functions instead of Legendre polynomials. Distribution function and elastic scattering cross-section are expanded in different systems of polynomials containing arbitrary parameters. The proper choice of these parameters allows optimizing the choice of the polynomials. The calculations made for the zero and first approximations show that at great distances from the source the proposed method is considerably more correct than the spherical harmonics method. (auth)

43196 AN ANALYTIC SOLUTION OF THE MULTIGROUP REACTOR EQUATIONS. Glushkov, E. S.; Ponomarev-Stepnoi, N. N.; Petsuhkova, N. A. At. Energ. (USSR), 26: 464-5(May 1969). (In Russian).

Although multigroup methods are widely used for neutron-physics calculations, under certain conditions the analytical approach is more effective. It was therefore proposed to generalize one of the solutions obtained by the authors in reactor design calculations for multiple radicals of the equation. The method was also used for calculating multiregion reactors by iterating the sources. A partial solution of the nonhomogeneous system was considered for two specific cases of the distribution of the fission sources. The relations obtained were used to develop a computer program for cylindrical one dimensional reactors, specifying boundary conditions which included the presence of an absorbing envelope at zone boundaries and albedo conditions at the next boundary. The program may be applied for calculating reactors with and without an absorbing envelope, using 5 to 9 iterations for the fission sources. (TTT)

43197 THE THEORY OF A ONE-DIMENSIONAL BARE REACTOR, TREATED BY THE LIE SERIES METHOD. Lemanska, M.; Ilamed, Y.; Yiftah, S. (Soreq Nuclear Research Center, Yavne, Israel). J. Nucl. Energy, 23: 361-7(July 1969).

The one-dimensional G-group diffusion equation for the bare reactor is solved using the Lie series technique. A method for calculating the critical size of a bare reactor is given. It is shown by numerical analysis that this method of calculation is simpler than the usual diffusion method. Numerical examples are given. (auth)

43198 NEUTRON TRANSPORT IN MONOENERGETIC CRITICAL CONFIGURATIONS WITH FINITE REFLECTORS. PART II. SPHERES. Leuthaeuser, Klaus-Dieter (Univ., Kiel). Atomkernenergie, 14: 254-6(July-Aug. 1969).

The monoenergetic critical problem is solved for a spherical core with a surrounding reflector of the same total cross section. The integral transport equation is shown to be identical with the Boltzmann equation for a fictitious problem in plane geometry, the solution of which is only slightly different from that of an actual multiplying slab with reflector. In case of wide-region reflectors the analysis can be simplified. By means of Case's normal-mode technique and the theory of singular integral equations a Fredholm equation for the continuum coefficients is derived, which, in combination with the critical condition, determines the core radius. Numerical results are presented. (auth)

43199 CANONICAL REPRESENTATION OF LINEARIZED COUPLED REACTOR KINETICS. Gabler, W. (AEG-Telefunken, Frankfurt am Main). Atomkernenergie, 14: 257-61 (July-Aug. 1969).

After the consideration of the linearized one-node neutron kinetics equations, Avery's neutron kinetics model of coupled reactors is analyzed in the complex frequency plane for both a one and two delayed neutron group case. The P-canonical representations are given. Two numerical examples for a fast-thermal system are solved and discussed. In addition, an estimate of the influence of the prompt jump approximation and number of delayed neutron groups is made. (auth)

43200 ON SOME NONLINEAR VOLTERRA EQUATIONS. Londen, Stig-Olof (Technical Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 317, 1-74(May 1969).

The behavior, as $t \to \infty$, of solutions of a class of nonlinear integrodifferential equations of Volterra type are analyzed. Results, concerning the existence of bounded solutions are derived. The validity of some numerical methods for obtaining approximate solutions of a class of nonlinear integral equations of Volterra type is examined. Applications to reactor dynamics are considered. (14 references) (auth)

43201 INVESTIGATIONS ON THE MACROSCOPIC NODAL APPROACH TO SPACE-DEPENDENT NUCLEAR REACTOR KINETICS. Stevenson, Michael Gail. Austin, Tex., Univ. of Texas, 1968. 219p.

Thesis.

The analysis of the space- and time-dependence of the neutron population in large nuclear reactor systems plays an important role in determining the controllability and safety of such systems. Several analytical and numerical methods have been developed and used for calculating the transient behavior of reactors in which the space- and time-dependence is nonseparable. The most useful of these are reviewed, and one, the macroscopic nodal approach, is examined in detail, particularly with regard to the approximations involved. In addition, the fission mode method is developed; this is a consistent formulation based on the separability of partial fluxes due to nodal fission sources. To evaluate the validity and usefulness of the nodal methods, comparisons are made of numerical calculations of the transient behavior of two reference reactor systems expected to show space-dependent kinetics effects. Region-averaged neutron fluxes were calculated for a series of transients by each of three methods: the gross coupling method; the effective D/L method; and the fission mode method. These are compared with similar results from fine-mesh finite-difference solutions by the WIGLE program. (Disser. Abstr.)

43202 STOCHASTIC MODEL OF A TWO REGION NUCLEAR POWER REACTOR WITH XENON: STATIONARITY AND STABILITY. Prescop, Val. Pittsburgh, Carnegie-Mellon Univ., 1968. 223p.

Thesis.

A two region stochastic model of a nuclear power reactor with Xe is considered as an example of a nonlinear stochastic process The model is developed from the basic probability balance describing events of interest, including neutron, I_2, and Xe formation and loss, as well as control events, which enable numerical requirements on the control parameters for stationary of the stochastic process to be established. The probability balance is transformed to the Forward Stochastic Equation, and the first and second moment equations extracted. A general probability distribution, as represented by a skew term, is included in the moment equations. Qualitative arguments for the use of the normal approximation are presented, and the effect of a highly skewed neutron distribution around the mean neutron number is demonstrated. The values of variances and covariances are calculated from the first and second moment equations, using an iterative procedure, with the use of a digital computer. Numerical criteria for the value of the feedback coefficient for marginal stationarity of the stochastic model are compared with the numerical criteria for the stability of the corresponding linearized deterministic model. Applications of the stochastic model to nuclear design practices and reactor operation are noted. (Disser. Abstr.)

43203 NUMERICAL STUDY OF HIGHER ORDER PERTURBATION THEORY. Saito, Reiko (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 359-70(July 1969).

The higher order perturbation theory is studied numerically. The one-dimensional diffusion equation is solved by the conventional (1st order) and the higher order (2nd and 3rd order) perturbation methods. The results are compared with those exactly calculated, and the accuracy, the effect of the high order terms and limit of the perturbation method are examined. When the perturbation in the reactor is non-uniform, the higher order perturbation method is found to be effective. When the perturbation is uniform, however, the higher order terms are of relatively small importance. (9 references) (auth)

43204 ON THE CRITICAL PROBLEM FOR A TWO-REGION SPHERE. Smith, O. J.; Siewert, C. E. (North Carolina State Univ., Raleigh). J. Nucl. Energy, 22: 579-86(Oct. 1968).

The one-speed critical problem is solved for a two-region sphere, where the total cross section is common, but different multiplication parameters in the two zones are permitted. A transform procedure is used to reduce the integral transport equation to a pseudo problem in slab geometry. This, in turn, is solved by Case's method of normal modes. The analysis leads to a Fredholm integral equation for the only unknown expansion coefficient. In addition, a critical condition, from which the allowable parameters of the problem are to be determined, is obtained. (auth)

43205 FURTHER REMARKS ON THE CALCULATION OF RATIOS IN CRITICAL SYSTEMS. Pomraning, G. C. (Gulf General Atomic Inc., San Diego, Calif.). J. Nucl. Energy, 22: 631(Oct. 1968).

A comparison is made of the two variational principles of Lewins [NSA 20: 18059] and Pomraning [NSA 21: 32025] for calculating the ratio of reaction rates in a critical system. The simplicity of the principles from a computational point of view is considered. (UK)

43206 EFFECTIVENESS OF DIFFERENT CRITERIA OF SPATIAL NEUTRON DISTRIBUTION STABILITY. Postnikov, I. S.; Sabaev, E. F. At. Energ. (USSR), 27: 112-15(Aug. 1969). (In Russian).

A possibility of using the D-breakdown method for calculation of the spatial neutron distribution stability is demonstrated on an example of a one-dimensional power reactor. With the aid of this method exact solution is derived for some definite values of parameters. This is a basis for treating the question of effectiveness of different criteria of spatial neutron distribution stability and determining limits of their effective application. 11 references. (auth)

43207 COMBINED MODEL OF NUCLEAR POWER UNIT FOR DYNAMIC STUDIES. Selivanov, V. M.; Sidorova, I. I.; Gribanov, Yu. I.; Karlov, N. P.; Patrushev, Yu. K.; Shcherbakov, I. E.; Gorev, A. A. At. Energ. (USSR), 27: 101-6(Aug. 1969). (In Russian).

The combined model imitates a two-circuit nuclear steam-generating unit with natural circulation of coolant in the first circuit and the self-control of power level due to the negative temperature reactivity. This combined model includes the so-called physical and electronic models. The physical model imitates thermal and hydraulic processes in the steam-generating unit. Water is used as a coolant, heat generation is simulated by electrical heating. Pressure in the first circuit is about $39 \cdot 10^4$ N/m^2, the maximum heat flux is 0.5 MW(t)/m^2. The electronic model is an analogue computer solving the equation of reactor kinetics with six groups of delayed neutrons. A reactor kinetics imitator giving the signal proportional to the neutron density operates the heat power of the physical model with the aid of a power converter. Such a combined system allows variance of neutron-physical parameters of a reactor rather simply and investigation of various dynamic regimes and accidents which may not be always reproduced in an operating installation. 5 references. (auth)

43208 CRITICALITY THEORY OF PILE IN WHICH FUEL DENSITY OSCILLATIONS ARE EXITED. Novikov, V. M. At. Energ. (USSR), 27: 107-11(Aug. 1969). (In Russian).

A one-group approximation pile criticality theory is presented for the case when the oscillations of gaseous fuel density are excited. It is shown that the pile reactivity increases when synchronous stationary waves appear in all canals. In reactors large enough this reactivity jump amounts to a dollar if amplitude of density oscillation is about 5% of mean density. It is also shown that amplitude of neutron flux oscillation is much larger than that of density oscillation. In principle these effects may be used for accident-free regulation of reactors as well as for obtainment of neutron flux pulsating with large amplitude. 4 references. (auth)

43209 CORRELATION FUNCTIONS OF N-TH ORDER WITH POISSON PRIMARY DISTRIBUTION OF THE NEUTRON FIELD. Ledinegg, E. (Technische Hochschule, Graz). Acta Phys. Austr., 28: 121-38(1968). (In German).

On the basis of a method developed by H. Borgwaldt and B. Stegemann for the calculation of second order correlation functions of the neutron field in a subcritical reactor, the correlation functions of the nth order ($n \geq 2$) were investigated. No special reactor theory or field equations were used in order to keep the results as general as possible. The generating function was used as a mathematical auxiliary. There remains the problem of resolving the generating function of the signal into generating functions which correlate the primary individual reactions, which can be determined by Green functions. A recursion formula was derived in which only more statistical moments occur whose order is reduced by a degree. (tr-auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 40915, 40916, 40924, 40928, 40930, 40934, 40975, 41090, 41092, 41147, 41157, 41529, 41534, 41535, 41537, 41541, 41561, 41563, 41564, 41573, 41575, 41582, 41584, 41585, 41602, 41604, 41628, 41629, 41644, 41684, 41700, 41701, 41703, 41705, 41712, 41717, 41723, 41724, 41726, 41727, 41734, 41751, 41752, 41756, 41759, and 43181.

43210 (CONF-670338, pp 245-50) DISTRIBUTION OF NUCLEAR MATERIALS OUTSIDE THE UNITED STATES. Bradley, R. G. (Division of International Affairs (AEC), Washington, D. C.).

Aspects of U. S. fuel supply policies of interest to foreign users are discussed with emphasis on toll enrichment of uranium. (H.D.R.)

43211 (DUN-SA-88) USE OF A DEACTIVATED HANFORD REACTOR CONTROL CENTER FOR AN OPERATOR TRAINING SIMULATOR. Bursey, R. J.; Hill, R. O. (Douglas United Nuclear, Inc., Richland, Wash.). Jan. 30, 1969. Contract AT(45-1)-1857. 11p. (CONF-690609-22). Dep. CFSTI.

From 15th Annual Meeting of the American Nuclear Society, Seattle, Wash.

Modification of the deactivated Hanford D Reactor for an operator training simulator is described. (auth)

43212 CONTROL ROD AND DRIVE MECHANISM THEREFOR. Humphries, John R. Jr. (to Gulf General Atomic Inc.). U. S. Patent 3,445,334. May 20, 1969. Filed Jan. 24, 1966.

A high speed control rod and its associated drive mechanism are described in connection with a nuclear reactor having a large prompt negative temperature coefficient. The control rod may be drawn upwardly from the core to cause a power pulse. The control rod is longer than the core and extends a substantial distance below the core. When it is withdrawn, this extra length enables the control rod to be accelerated to a substantial velocity before any effective change in reactivity of the core occurs. A piston located on the linkage mechanism close to the control rod coacts with a dash pot cylinder to brake the mechanism after the control rod is withdrawn and, because of its position, places a tensile stress on most of the linkage during braking. (Offic. Gaz.)

43213 DEVICE FOR MEASURING THE POWER OUTPUT OF A NUCLEAR REACTOR. Nomura, Tsutomu (to Nippon Atomic Industry Group Co.). Japanese Patent 1969-9557. May 2, 1969. Filed June 19, 1964.

In the method proposed, the output current or pulses of a CIC, FC or BF$_3$ detector are not directly used. The fluctuation in detector output is amplified corresponding to the fluctuation of reactor neutron density. The direct proportionality of the fluctuation power-spectrum density to the in-pile neutron density is applied. The advantages obtained are the increased safety, high measuring accuracy over a wide range, easy measurement, and low cost. The device includes the following: the nuclear reactor whose power output is measured; a neutron detector inserted into the reactor; and means for measuring the average squared value in which the component of fluctuation in the detector output is applied and only the detector fluctuation component among the power-spectrum density in the neutron-density fluctuation is calculated. (NSA of Japan)

43214 NUCLEAR REACTOR. Inaba, Eiji (to Nippon Atomic Industry Group Co.). Japanese Patent 1969-10797. May 1, 1969. Filed Apr. 25, 1964.

For scramming the nuclear reactor, the following three steps, applicable either singly or in combination, are employed: a gas is introduced into the neutron-moderating water; control rods are inserted fully into the reactor core, or the fuel rods are ejected from the reactor core; and when the first and second steps are not effective, slurry containing a neutron-absorbing substance is injected into the core. With the first step, the rapid decrease in reactivity is achieved in such cases as a violent earthquake. Then, by the second step, the absolute scramming is attained by nullifying the reactivity; the re-start of the reactor is easy since the reactor core is not polluted with neutron-absorbing material. The third step is used as final measure. This injection is made into the vital region of the reactor core, and the neutron-absorbing substance is in the form of slurry, so that the treatment of the reactor after scramming is rendered both easy and simple. (NSA of Japan)

43215 DEVICE FOR DRIVING A REACTOR CONTROL ROD. Mikami, Takao (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-9957. May 9, 1969. Filed Feb. 28, 1966.

The reactor control rod driving device proposed, using hydraulic power, has the following advantages: easy and smooth insertion of control rod over the full length, small hydraulic pressure necessary for withdrawing a control rod, and simple but positive mechanism of the drive. A control rod is connected to an index tube below it. Hydraulic pressure is applied to raise the control rod embodied with the index tube into the reactor. On the inside surface of this cylinder, hollows are cut at regular intervals, into which the claws of an inner tube engage. When the cylinder moves upward, the claws are detached from the hollows. An outer cylinder surrounds the cylinder connected to a control rod. A means to release hydraulic pressure through the upper part of this outer cylinder is installed. (NSA of Japan)

43216 DEFECTED ZIRCALOY CLAD FUEL. Locke, D. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Nucl. Eng. Int., 14: 648-52(Aug. 1969).

Earlier correlations relating operating heat flux to the time of gross failure after initial defection are examined in the light of Zircaloy pin failures reported since 1963. Limiting levels for extended operation of defective fuel are shown to be 500,000 to 550,00 550,000 BTU/h ft^2 peak heat flux at a coolant temperature of 260° to 330°C. The internal clad temperature is the dominant feature. (UK)

43217 CONTROL ROD EFFECTIVENESS MEASUREMENTS VERSUS SUPERCELL CONCEPT AND HETEROGENEOUS THEORY. Haroon, M. R. (Georgia Inst. of Tech., Atlanta). J. Brit. Nucl. Energy Soc., 8: 232-36(July 1969).

Control rod effectiveness of mild steel in a subcritical (natural U, graphite moderated) assembly was investigated. Thermal neutron flux measurements were carried out to evaluate change in buckling in the axial direction, before and after the introduction of control rods, while buckling in the radial direction was assumed to be constant. The control rod was placed in a vacant position of fuel lattices comprising a supercell. The number of fuel elements was successively decreased. Results were correlated on the basis of heterogeneous theory (source-sink) and supercell concept. The control rods were assumed to be transparent to fast neutrons, and the extrapolated-length type of boundary condition was applied at the surface of the rods. Predictions of supercell concept showed wide variations in comparison with experimental measurements and are of very little use. For valid comparisons with heterogeneous theory, the reactivity had to be defined as the product of change in buckling and diffusion area, in contrast to the accepted use of migration area. The bases for this change are discussed. Results agreed within an error of 0.5% and emphasize the usefulness of heterogeneous theory when the number of fuel elements is reduced. (auth)

43218 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. Perrin, Alfred James; Reimers, Stafford David Ian (to Babcock and Wilcox Ltd.). British Patent 1,159,971. July 30, 1969. Filed July 2, 1965.

Reference is made to fuel elements incorporating latching means by which they may be positionally secured within a reactor, with provision for automatic disengagement of the latching means. In the system described an actuator is provided which is moveable between a first position in which it holds the latching means in a latching condition and a second position in which it holds the latching means in an unlatched condition. A handling portion is attached to the actuator and is also attached to the fuel element body, through a lost motion connection, so that raising the handling portion first moves the actuator from its first position to its second position and then raises the entire fuel element. Various designs of appropriate fuel elements are described. (UK)

43219 DEVELOPMENT STATUS OF SIMULATOR FOR POWER SYSTEM INCLUDING ATOMIC POWER STATION. Wakamatsu, Seiji (Electrotechnical Lab., Tokyo). Ohm (Elec. Mag.), 56: No. 3, 30-4(Mar. 1969). (In Japanese).

Studies in progress on the development of a simulator for the nuclear reactor power system are described. The purpose of the simulator is to analyze various problems of system control arising when an atomic power station is introduced into the already complicated power system. (NSA of Japan)

43220 DEVELOPMENT STATUS OF SIMULATOR FOR OPERATION TRAINING OF ATOMIC POWER STATION. Tachibana, Akira (Japan Atomic Power Co., Tokyo). Ohm (Elec. Mag.), 56: No. 3, 24-9(Mar. 1969). (In Japanese).

Concerning the simulators for training the operators of atomic power plants, the following are described: operation of atomic power plants; training-purpose simulators; the simulators in the JAPC Tokai training school (for the improved Calder Hall type and for the BWR type); and recent U. S. simulators for light-water atomic power plants. (NSA of Japan)

43221 A SURVEY ON THE STATE OF ATOMIC ENERGY DEVELOPMENT AND UTILIZATION. Genshiryoku Iinkai Geppo, 14: No. 3, 27-36(Mar. 1969). (In Japanese).

A survey was made by the Science and Technology Agency on the state of atomic energy development and utilization in Japan as of March 1968. The survey included atomic energy personnel, research and development, investment, and production. The total number of personnel engaged in the organizations concerning atomic energy was 29,240, 39.8% in private enterprises, 26.3% in medical institutions, 20.4% in research institutions, and 12.8% in education and training institutions. (NSA of Japan)

43222 PROGRESS OF THE ATOMIC ENERGY RESEARCH IN JAPAN FOR TEN YEARS. Kuroda, Yoshiteru (Tokai Univ., Tokyo). Nippon Genshiryoku Gakkaishi, 11: No. 2, 3-22(Feb. 1969). (In Japanese).

About ten years have passed since the peaceful uses of atomic energy entered the stage of research and development in Japan. Although the progress in ten years has not necessarily been constant and steady, the present state in Japan can be considered as ready to go into the stage of independent posture. The past ten years of progress in the atomic energy research in Japan are described on the following: introduction and her own development of nuclear reactors; reactor physics; shielding; instrumentation and control; heat transfer, structural strength, and pressure vessels; nuclear fuels and structural materials; nuclear-fuel reprocessing, radioactive wastes treatment, and radioisotopes separation; radiochemistry; radiation chemistry; and health physics. (NSA of Japan)

43223 NUCLEAR REACTOR ROD CONTROLLER. Jabsen, Felix S. (to Babcock and Wilcox Co.). U. S. Patent 3,462,345. Filed May 10, 1967.

An improved control arrangement for moving a nuclear reactor control rod in and out of a nuclear reactor core is described. The arrangement includes a guide tube partially disposed in the core and within which the control rod is axially movable. A removably mounted, spring loaded-closed, valve is associated with the guide for regulating the flow of primary cooling fluid. A removably mounted electromagnet, adapted to carry a push rod for actuating the valve, may be manually or automatically energized to normally open the valve. With the valve open, some of the coolant flows through the guide into a bypass chamber and, in so flowing, entrains the control rod for motion out of the core. Deenergizing the electromagnet releases the valve for closing off the flow of fluid through the guide tube to allow the control rod to move into the core under the influence of gravity. (Offic. Gaz.)

43224 SPACER FOR FUEL ASSEMBLIES IN A NUCLEAR REACTOR. Glandin, Constan (to Allmaenna Svenska Elektriska Aktiebolaget). U. S. Patent 3,457,140. Priority date Dec. 30, 1966, Sweden.

A spacer for a nuclear fuel assembly is described. The spacer comprises an outer frame surrounding two rigid grids in spaced relationship to each other and bent, strip-like and resilient spacer springs supported by and extending between the two grids. Each grid comprises a plurality of polygonal meshes and each spring has opposite ends fixed to the grids at the corners of the meshes and a varying strip width to provide an optimal spacer from the flow point of view. (Offic. Gaz.)

GENERAL

43225 (BNL-50149, pp 15-18) NUCLEAR MATERIALS DIVISION. Kouts, H. (Brookhaven National Lab., Upton, N. Y.).

In March 1968 the AEC established the Nuclear Materials Division as a support organization for the Office of Safeguards and Material Management. The functions of the Division are described, and the tasks initiated during the report period are summarized. Some results of a cost study of the IAEA safeguards system are presented. (H.D.R.)

43226 (BNL-50158) INFORMATION THEORY AND BIOLOGY: A CRITIQUE AND RESYNTHESIS. Brookhaven Lecture Series No. 68. Johnson, Horton A. (Brookhaven National Lab., Upton, N. Y.). Sept. 20, 1967. 15p. Dep. CFSTI.

The history of the development of a general quantitative theory applicable to the life sciences is reviewed, and the current impasse in the fulfillment of this concept is analyzed. This impasse centers around the inability to define biological information in physical terms only. Such definition must include an intensive factor that is uniquely biological. Suggestions are presented regarding some new directions out of which may evolve an information theory for use as a general calculus for living systems. (E.R.B.)

43227 (CEA-R-3837) FACTORS AND UNCERTAINTIES IN THE PROFITABILITY OF USING NUCLEAR ENERGY IN DESALINATION OF WATER. Thiriet, Lucien; Lievre, Paul (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1969. 31p. (In French and English). (CONF-681108-3). Dep. CFSTI (U. S. Sales Only).

From Symposium on Nuclear Desalination, Madrid, Spain.

One of the economic advantages of nuclear energy consists of the small proportional element in its cost structure. Economies of scale favour the nuclear station as compared with the conventional thermal one, and when the demand for electricity and heat, in particular for desalination, are sufficient, nuclear energy may, subject to certain conditions, prove advantageous. The validity of the conclusions reached according to the hypotheses adopted is discussed. The different kinds of uncertainties connected with technical, economic, and financial data (the various transmission coefficients, the life of equipment according to the choice of materials, changes in prices, the form of price functions and interest rates) and with the various constraints, are examined and discussed. The uncertainties connected with the method of optimization used and the criterion of selection adopted are examined and discussed. It is shown thereby that it is usually extremely difficult to assume absolutely the competitiveness, or conversely the noncompetitiveness, of using nuclear energy in the desalination of water, and that a large number of aspects have to be carefully examined. (auth)

43228 (CONF-670338, pp 229-41) NUCLEAR ENERGY IN CANADA. Lambe, L. A.; Wyatt, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

The main activities of AECL are reviewed. They include scientific research and development in the nuclear energy field; the development of economic nuclear power; the operation of nuclear reactors; and the production and marketing of radioisotopes and associated equipment such as medical teletherapy units and gamma irradiators. (auth)

43229 (CONF-670338, pp 257-60) ORGANIZATION OF AMERICAN STATES AND NUCLEAR SCIENCE AND TECHNOLOGY. Alonso, M. (Inter-American Nuclear Energy Commission, Washington, D. C.).

The Organization of American States (OAS) is a regional organization of nations which draws its membership from the countries of North and South America. Following recommendations made at an OAS meeting in 1956, the InterAmerican Nuclear Energy Commission (IANEC) was organized to fill the need for a means of coordinating efforts being made in the field of nuclear energy. Through the OAS, efforts are being made to promote collaboration and mutual understanding among Latin American countries in the field of nuclear energy. Organizing conferences and symposia and coordinating the movements of scientists are just two of the functions it serves. The OAS's ultimate goal is to see an integrated scientific and technological community in Latin America contributing to the eventual integration of the continent. (auth)

43230 (CONF-670338, pp 261-70) ACTIVITIES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY IN LATIN AMERICA. Spitalnik, Jorge (International Atomic Energy Agency, Vienna (Austria)).

As a part of its goal to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity, the IAEA has been playing an increasingly active role in the field of applied nuclear energy among its member states. In view of the industrial expansion that is taking place in the Latin American countries, all of which are now members of the Agency, special attention has been devoted by the Secretariat to planning the Agency's activity in Latin America. The IAEA's efforts have dealt with the implementation of research projects in the field of nuclear energy, the utilization of nuclear power and desalination, the application of the IAEA safeguards system, and technical assistance. (auth)

43231 (CONF-670338, pp 277-87) EDUCATION AND NUCLEAR ENERGY IN LATIN AMERICA. Smith, Craig B. (California Univ., Los Angeles).

Between 1970 and 1980 nuclear power is expected to begin a new period of growth in Latin America. It is by no means certain that facilities are or will be available for training the large numbers of technicians, operators, engineers and other specialists who will be needed. Some of the problems (lack of facilities, obtaining and keeping experienced faculty, quality of instruction) are discussed, and a proposal for university-to-university cooperative programs is described. This program would be used to better develop and staff graduate courses in nuclear science and engineering in Latin American institutions. (auth)

43232 (CONF-670338, pp 315-16) NUCLEAR ENGINEERING AT THE NATIONAL POLYTECHNIC INSTITUTE (MEXICO). Fazzolare, R. A. (Instituto Politecnico Nacional, Mexico City).

The Graduate School of Physics and Mathematics of the National Polytechnic Institute has four departments, one of which is nuclear engineering. The nuclear engineering program offers studies leading to the MS degree. Equipment in the department laboratories includes nuclear instruments and measuring equipment, a subcritical assembly and a gamma irradiation facility. When the new National Nuclear Center at Salazar is complete, the Department will have access to a TRIGA MARK IV research reactor. (auth)

43233 (CONF-670338, pp 317-20) A VIEW OF NUCLEAR EDUCATION IN BRAZIL. Cimbleris, B. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro).

The history of nuclear science and engineering in Brazil is reviewed. Educational facilities and programs in nuclear engineering are summarized. (H.D.R.)

43234 (CONF-670846) CONFERENCE ON SPECIAL TOPICS ON NUCLEAR EDUCATION AND RESEARCH HELD IN GATLINBURG, TENNESSEE, AUGUST 28-30, 1967. (Oak Ridge Associated Universities, Inc., Tenn.). Apr. 1969. 284p. Dep. CFSTI.

Eleven papers are included on the activities of selected universities, of industry, and of government agencies in nuclear fields. Individual abstracts were prepared for 7 of the papers. The remaining 4 papers include brief summaries of nuclear education programs at the University of Virginia, Pennsylvania State University, and North Carolina State University and a forecast of the U. S. total electric power and nuclear power growth. (H.D.R.)

For abstracts of individual papers see: 41680, 42010, 42011, 42345, 43132, 43170, and 43191.

43235 (CONF-680964-1) MEASUREMENTS OF HIGH-ENERGY PULSED-LASER RADIATION INTENSITY. Barkhudarova, T. M.; Voronov, G. S.; Gorbunov, V. M.; Delone, G. A.; Delone, N. B.; Martakova, N. K. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). [1967]. 24p. (In English and Russian). Dep.

From Conference on Laser Measurements, Warsaw, Poland.

An account of a method of a powerful laser radiation intensity measurement is given. Methods of a spatial-temporal radiation distribution measurement are considered. The typical experimental data for different lasers and accuracies of the intensity of measurement is reduced. An account of specific questions of the nonlinear processes probability measurement is given. The experimental accuracies of the nonlinear 4 to 15 order processes probability measurement are reduced. (auth)

43236 (COO-1469-124) COMPUTER SYSTEMS RESEARCH. Annual Report, September 1, 1968-August 31, 1969. (Illinois Univ., Urbana. Dept. of Computer Science). 41p. Dep. CFSTI.

In the software area, accomplishments include completion and distribution of ODESSY, the automatic differential equation package; the success of the new methods for stiff equation on a high altitude chemical reaction problem with Kirkland AFB; the implementation of the master program library tester; and the introduction of the file editing/remote job entry system. In hardware, the accomplishment highlights are the completion of the Tricolor Cartograph, the automatic coloring machine; the completion of the ORBIT bandwidth compression scheme for line drawings; the completion of phase one of the VISTA bandwidth compression scheme for gray scale information; the completion of the stochastic array computer, RASCEL (supported together with ONR); the completion of the bundle processing machine, BUM (supported together with ONR); the completion of POTENTIOMATRIX, the equipotential line display system (supported together with ONR); and the completion of phase one of the on-line Fourier Transform system and demonstration of the feasibility of the principle. (auth)

43237 (DUN-5247) ENGINEERING STUDY. FIRE PROTECTION IMPROVEMENTS: 100-N AREA FOR ESSENTIAL ELECTRICAL AND ELECTRONIC EQUIPMENT. Hoffman, R. C. (Douglas United Nuclear, Inc., Richland, Wash.). June 12, 1969. 28p. Dep. CFSTI.

A preliminary engineering study has been made to improve the fire protection and to reduce hazards for 100-N Area EEEE and improve the "Improved Risk" status. The proposed work would include the following: a. Manually operated dry pipe sprinklers for Rooms 6 and 145 at 105-N to serve as backup for the existing carbon dioxide systems (capital project). b. Additional ventilation for the Askarel insulated instrument power supply transformers in Room 6 at 105-N to secure compliance with National Electrical Code (AR work). c. EEEE enclosure sealing to improve protection from moisture and dust (expense work). (auth)

43238 (LA-3756) THE 1965 ARPA-AEC JOINT LIGHTNING STUDY AT LOS ALAMOS. VOLUME III. COMPARISON OF THE LIGHTNING SPECTRUM AS MEASURED BY ALL-SKY AND NARROW-FIELD DETECTORS. PROPAGATION OF LIGHT FROM LIGHTNING INTO ALL-SKY DETECTORS. Connor, T. Robert; Barasch, Guy E. (Los Alamos Scientific Lab., N. Mex.). July 25, 1968. Contract W-7405-eng-36. 25p. Dep. CFSTI.

Source spectra emitted by first return strokes of lightning are derived from "all-sky" radiometer data recorded by EG&G in 1965 during the Los Alamos lightning study and are found to agree, within experimental accuracy, with the source spectrum of first return strokes derived from spectrograph and collimated-radiometer data presented in detail in earlier volumes. The source spectra are obtained using an empirical atmospheric transmission correction which varied from storm to storm. The 165° field of view "all-sky" detector sees no direct light except from very close strokes, and atmospheric transmission is considered in two parts: a distance-dependent part as light travels from the source to the cloud surface or atmospheric volume above the detector, and a distance-independent part as the light is then scattered into the detector. (auth)

43239 (LA-4202) THREE-DIMENSIONAL STUDY OF FLOW BETWEEN CONCENTRIC ROTATING CYLINDERS. Meyer, Kenneth A. (Los Alamos Scientific Lab., N. Mex.). July 1968. Contract W-7405-eng-36. 12p. Dep. CFSTI.

The wavy vortex mode of flow between concentric rotating cylinders is studied, using a combination of Fourier analysis and finite differencing. Series expansions of the form $u(r,z,\theta,t) = u_0(r,z,t) + u_1(r,z,t) \sin n\theta + \bar{u}_1(r,z,t) \cos n\theta + \ldots$ are introduced into the full Navier-Stokes equations. The resulting time-dependent partial differential equations for u_0, u_1, $\bar{u}_1$, etc., obtained by separating the various harmonics, are solved by finite differencing in the r,z plane. Numerical results were obtained at Reynolds numbers of 750, 1000, and 2000 at a radius ratio (of outer to inner cylinder) of 1.2. The growth rates of small three-dimensional disturbances are obtained for a laminar base flow and a Taylor-cell base flow. Azimuthal wave velocities for small-disturbance cases and the fully established wavy mode case are obtained, and agree with linear stability calculations and experiment. The effect of the three-dimensional motion (at constant axial wave number) on the torque is examined and appears to be small. The effect, on torque, of varying axial wave number is reconsidered, and it is suggested that this is the predominant mechanism that affects the torque in the wavy mode regime. (auth)

43240 (NP-17899) REACTOR DAY 1969 OF THE GERMAN ATOMFORUM. Winnacker, Karl (Deutsches Atomforum e. V., Duesseldorf (West Germany)). Apr. 16, 1969. 19p. (In German). Dep.

A brief review is given of the history and development of reactor technology in Germany. Discussions are given on the following topics: U enrichment studies, particularly through gas centrifugation; fuel cycle studies, including fuel reprocessing, recovered fuel recycle, and radioisotope separation; heavy water production, development of the Heavy Water Reactor (HWR); pebble bed reactor start-up; and development of the Thorium High Temperature Reactor (THTR). (F.J.W.)

43241 (ORC-67-17) NOTES ON OPERATIONS RESEARCH-6. (California Univ., Berkeley. Operations Research Center). May 1967. 105p.

Topics include divisible activities in critical path analysis; a nonlinear nonconvex programming problem; an algorithm for a machine loading problem; nonplanar networks and coherent structures; generalized upper bounded techniques for linear programming; comparison of the primal, dual, and primal-dual decomposition algorithms; and external problems in queuing theory. (W.H.K.)

43242 (ORNL-3300(Vol.8)) PUBLICATIONS, REPORTS, AND PAPERS FOR 1968 FROM OAK RIDGE NATIONAL LABORATORY. O'Hara, F. M. Jr.; Klein, Ann S. (eds.) (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 327p. Dep. CFSTI.

43243 (ORNL-4419(Summ.)) THE MOLECULAR ANATOMY PROGRAM. (THE MAN PROGRAM). Semiannual Progress Report No. 2, September 1, 1968-February 28, 1969. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. 55p. Dep. CFSTI.

Unique new analytical and separative systems continue to be evolved under the Joint NIH-AEC Molecular Anatomy (MAN) Program. The K-II ultra-centrifuge is now in commercial production and has made possible wide-spread use of the technique of continuous-sample-flow-with-banding for the production of a new spectrum of high-purity vaccines. Theoretical and experimental studies with the K-II indicate anomalous flow in the taper volume suggesting a new design (the so-called zero taper core) for the titanium K-III. Evaluation of the K-III demonstrates markedly superior performance. Large-scale rate-zonal isolation of human α_2 macroglobulin, which is radio-protective after exposure and is thus important in cancer radiotherapy, requires special cores. The K-IV and K-V 6.7-liter cores present several difficult operating problems which have recently been solved. The widespread use of specific insect polydedrosis viruses as insecticides is dependent on the development of large-scale purification procedures which would provide material of sufficient purity for spraying in watershed and recreational areas and for extensive animal testing. Advanced experimental K-series rotors have been developed which solve this problem. For studies on human serum lipoprotein dyscrasias, especially those implicated in arteriosclerosis and for the isolation of cell membrane lipoproteins, ultracentrifuges are required which will retain steep gradients suitable for banding low-density, high-density, and very high-density lipoproteins. Theoretical and experimental studies have led to the design and fabrication of the B-XXXIV flotation ultracentrifuge which will improve the zonal lipoprotein separations now being widely adopted. Tumor transplantation antigens capable of immunizing hamsters against SV40 and adenovirus 31 transformed tumor cell challenge have been demonstrated in cell fractions. Further progress requires the development of methods for isolating plasma membranes in large quantity which are now under development. Progress in analysis of macromolecules requires development of automatic devices for analyzing mixtures of amino acids, nucleotides, sugars, and other monomers. Considerations of the space and time requirements lead to the conclusion that miniaturized analyzers should be developed. The nucleotide and sugar analyzers developed under this program have found important application in the analysis of human urine. Over 140 ultraviolet absorbing compounds and over 30 carbohydrates have been observed, of which 21 of the former and 16 of the latter have been identified. Prototype miniaturized amino acid and nucleotide analyzers have been built and are undergoing tests. A new approach to the problem of fast analyzers has been originated at Oak Ridge and carried past theory development to the construction of prototypes. These make possible data generation at a rate and in a form directly compatible with electronic computers. The adaptation of small computers to the problem of real-time data reduction is in progress. Zonal rotors yield a large number of fractions. Theoretical studies on gradient capacity, anomalous sedimentation in density gradients, and on hydrodynamic shear during gradient reorientation continue to be productive. (M.M.B.)

43244 (RLO-1725-155) HIERARCHICAL ANALYSIS OF VARIANCE OF SHELF SEDIMENT TEXTURE. Kelley, James C.; McManus, Dean A. (Washington Univ., Seattle. Dept. of Oceanography). [1969]. 21p. Dep. CFSTI.

A number of geologic inferences are made from studies of the geographic distributions of sediment textural variables. Evaluation of such distributions requires that information on the total within-station variability be available. In order to obtain information on the relative magnitudes of the within-station and among-station variabilities, bottom sampling on the continental shelf of Washington was done in a stratified-multistage scheme on traverses placed by a systematic random system along the coast.

Duplicate samples were taken at each of 450 stations and duplicate analyses of nine textural variables were made on each sample. Complete analyses are available for 130 stations. This sampling design leads directly to a three-level, hierarchical analysis of variance in which the F-ratios of the mean square among stations to that within stations are measures of the raliability of distributions. The most diagnostic variables for differentiating stations are percentage of sand, percentage of silt, sand/mud ratio, and median phi size. The least diagnostic is percentage of clay. (auth)

43245 (SC-RR-68-523) OBSERVATIONS OF ATMOSPHERIC DENSITY, TEMPERATURE, AND WINDS OVER KAUAI. Smith, Lawrence B. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 91p. Dep. CFSTI.

Neutral atmospheric density and temperature data between 30 and 110 km and wind measurements between 30 and 70 km as obtained from 15 falling sphere experiments are presented. Twelve experiments were made over Kauai, Hawaii, two were made over Tonopah Test Range, Nevada, and one over Johnston Atoll. During some of the sphere experiments rocketsonde and radiosonde data were obtained which are also presented. Comparisons are made with similar measurements at low latitudes and with standard atmospheres. A definite seasonal difference is shown above 80 km, with densities higher in winter than in summer or standard. Wintertime temperatures are 10 to 15 degrees K warmer in the mesopause region than in summer or in the standards. A 6-hour change in temperature of 20 degrees K between 67 and 87 km was also observed. Recommendations for additional experiments needed to define more exactly the atmospheric background and its variations in the 30- to 110-km region over Kauai are presented. (auth)

43246 (SC-RR-69-485) COMPUTATION WITH THREE-TERM, LINEAR, NONHOMOGENEOUS RECURSION RELATIONS. Amos, D. E.; Burgmeier, J. W. (Sandia Labs., Albuquerque, N. Mex.). July 1969. 46p. Dep. CFSTI.

The problem of stable computation by forward and backward recursion on three-term, linear, nonhomogeneous recursion relations is outlined. The backward recursive theory is applied to integrals commonly arising in mathematical physics, including incomplete Laplace transforms of repeated integrals of the error function, moments of some Bessel functions, and the incomplete gamma function. 9 references. (auth)

43247 (SCL-DR-69-59) NUMERICAL-COMPUTATIONS OF THE PLANE STRESS INTENSITY FACTORS FOR HOLLOW CYLINDERS UNDER TORSION, FLEXURE AND PRESSURE. Emery, A. (Sandia Labs., Livermore, Calif.). July 1969. Contract AT-(29-1)-789. 44p. Dep. CFSTI.

The solution of the states of stress in hollow cylinders which are subject to torsion, flexure, and pressurization is studied. The cylinders are taken to be infinite in extent with cracks parallel to the generating axis and extending the full length of the cylinder. Both the states of stress and the stress intensity factors are determined numerically by the method of Emery and Segedin. It is shown that the stress intensity factors for the pressurized hollow cylinder are bounded by the valves for equivalent centrally cracked and edge cracked rectangular plates and that the valves for torsion and flexure may be correlated through normalizing by the maximum shear stress and the cylinder thickness. (auth)

43248 (STI/DOC-10/98) IAEA LABORATORY ACTIVITIES. The IAEA Laboratories at Vienna and Seibersdorf; The International Laboratory of Marine Radioactivity at Monaco; The International Centre for Theoretical Physics, Trieste; The Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo. Sixth Report. Technical Reports Series No. 98. (International Atomic Energy Agency, Vienna (Austria)). 1969. 154p. IAEA: $4.00; Austrian Schillings 104,-; £1.13.4; F Fr. 19,60; DM 16,-.

Development and work during the year 1968 are described. Activities of the IAEA Laboratories at Vienna and Seibersdorf, the International Laboratory of Marine Radioactivity at Monaco, the International Centre for Theoretical Physics at Trieste, and the Middle Eastern Regional Radioisotope Centre for the Arab Countries at Cairo are included. (auth)

43249 (SU-IPR-314) FAST REVERSAL MAPPING FOR THE SOLUTION OF TWO-DIMENSIONAL OPERATORS. LeBail, Roland (Stanford Univ., Calif. Inst. for Plasma Research). June 1969. Contract AT(04-3)-326. 16p. Dep. CFSTI.

Methods, other than Fourier or Hadamard transforms, which rely on large, fast computers and rapid computational techniques for transforming two-dimensional operators, are discussed. A prototype finite differences operator utilized for solution of inhomogeneous second order partial differential equations is constructed. Its transform is derived and the computational procedures are described. (M.L.S.)

43250 (TID-25145) ELECTRONIC PROPERTIES OF LIQUID WATER. Annual Progress Report, November 1, 1968–October 31, 1969. Report No. 1. Painter, Linda R. (Tennessee Univ., Knoxville. Dept. of Physics). July 1969. Contract AT(40-1)-3861. 10p. Dep. CFSTI.

Improved data on the reflectance of distilled water were obtained. These data were taken with sufficient accuracy and precision to allow determination of the optical constants. Additional data were taken on a saturated solution of sodium chloride in distilled water, and these reflectances were analyzed also to reveal the optical constants. Related to the analysis of these data was an extensive study of the polarization of concave diffraction gratings in the vacuum ultraviolet spectral region. (M.H.R.)

43251 (UCRL-50571) ROLE OF THYMIDINE KINASE IN DNA SYNTHESIS. Duafala, Thomas (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 7, 1969. 31p. Dep. CFSTI.

A critical review of the literature on thymidine kinase and its relation to DNA synthesis is presented. Major conclusions from this review can be summarized as follows. In the plant and animal tissues studied, there was demonstrated a marked periodicity in the activity of the enzyme in relation to the mitotic cycle. The enzyme activity also seemed to be higher in rapidly proliferating tissues than in slowly proliferating tissues. This increase in activity was attributed to new enzymatic protein. The periodic decrease in enzyme activity was shown to be energy-dependent, and may be related to a breakdown of the enzyme components. The enzyme is also very sensitive to thymidine triphosphate inhibition, the inhibition increasing with increased proliferation rate. Recently both thymidine kinase and the E-group human chromosome were associated with the malignant state. This review covers the period from 1958 through 1968. (144 references). (auth)

43252 (Y-1682) STATISTICAL ANALYSIS OF THE RESULTS OF A SERIES OF EXPERIMENTS ON THE CARBON-FOAM PRODUCTION PROCESS. Lever, W. E.; Gerwels, J. M.; Holland, C. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 5, 1969. Contract W-7405-eng-26. 21p. Dep. CFSTI.

A statistical analysis was performed on the results of four experiments conducted on the carbon-foam production process. The factors that appeared to be most important in the production of carbon-foam castings were identified. (auth)

43253 GENETIC ASPECTS OF LEUKEMIA. Zuelzer, Wolf W.; Cox, Douglas E. (Children's Hospital of Michigan, Detroit. Wayne State Univ., Detroit). Seminars Hematol., 6: 228-49 (1969).

The facts reviewed here indicate that the three major forms of leukemia, acute (AL), chronic granulocytic (CGL), and chronic lymphocytic (CLL), are genetically unrelated and should be considered separately. No evidence for genetic factors in CGL was found. Their significance for the genesis of familial clusters of CLL remains uncertain, but the small number of such cases suggests at most a minor role. The same is true for AL. Even in identical twins concordance for AL appears to be determined more by age at onset than by genetic identity, and twin studies cannot be interpreted as evidence for a prezygotic origin of childhood leukemia. The incidence of chromosomal aberration in nonleukemic cells (other than trisomy 21) in AL of childhood was found to be less than 2% in a series of 200 cases. The apparent association of AL with a variety of chromosomal and perhaps immunologic disorders of genetic origin suggests, however, that genetic mechanisms form part of the causal chain of leukemogenesis in a small minority of cases. The clues derived from this group must be viewed against the essentially negative evidence of genetic factors in AL generally, and interpreted in the light of known relations concerning experimental leukemias and the action of leukemogens such as radiation. Obviously, not all high risk subjects develop leukemia, and equally obviously many persons not burdened with an unfavorable genetic constitution do. In the murine leukemias a complex interaction among host factors and extraneous factors determines the incidence latency, (and) hematologic type. For man, in whom the situation is likely to be even more complex, this model implies a graded series of probabilities involving constellations of as yet largely hypothetic factors and culminating in the occurrence of a successful malignant mutation. If these involve viruses, many factors apart from genetic (chromosomal, immunologic, and perhaps, as in the mouse, histocompatibility) determinants can be visualized. Among these might be the mitotic rate of a given cell population, the timing of the exposure in relation to age, immunity or the lack thereof, and perhaps dosage effects, for conceivably the infection might be lethal to affected cells. The site of entry of the hypothetic virus into the genome might be critical. One can obviously ex-

tend this list ad infinitum, and it may only be added that the survival of the transformed cell (or cells) may depend on a number of unknown variables. Given these complexities, leukemia becomes a disease of probability in which genetic factors constitute one of many and generally more important determinants, and no classic patterns of inheritance can be expected even where they are relatively strong. Complex situations, unfortunately, demand complex hypotheses. (auth)